B.TECH. PROGRAMME

CURRICULUM

for 2015 admissions onwards

GENERAL INFORMATION

Code Numbering:

Each course is assigned an 8-character Code number. The first two digits indicate the year of curriculum revision. The next three letters indicate the Department offering the course. The last three digits are unique to the course – the first digit indicates the level of the course (100, 200, 300, 400 etc.); the second digit indicates the type of the course, viz. 0, 1 and 2 indicate the core courses; 3,4,5,6 and 7 indicate the Elective courses; 8 indicates the Lab. or practical-based courses and 9 indicates Projects.

ABBREVIATIONS USED IN THE CURRICULUM:

Cat. - Category;
L - Lecture;
T - Tutorial;
P - Practicals;
Cr - Credits;
ES - Exam Slot;
ENGG. - Engineering Sciences (including General, Core and Electives);
HUM - Humanities (including Languages and others);
SCI - Basic Sciences (including Mathematics);
PRJ - Project Work (including Seminars).

Departments

AES - Aerospace Engineering;
CHE - Chemical Engineering;
CHY - Chemistry;
CSE - Computer Science and Engineering;
CUL - Cultural Education;
CVL - Civil Engineering;
ECE - Electronics and Communication Engineering;
EEE - Electrical and Electronics Engineering;
EIE - Electronics and Instrumentation Engineering;
HUM - Humanities and Languages;
MAT - Mathematics;
MEC - Mechanical Engineering;
PHY - Physics;
SWK - Social Work.

AEROSPACE ENGINEERING

Semester I

Cat.	Code	Course Title	L-T-P	Cr	ES
HUM	15ENG111	Communicative English	2 0 2	3	A
SCI	15MAT111	Calculus and Matrix Algebra	2 1 0	3	B
ENGG	15CSE100	Computational Thinking and Problem Solving	3 0 2	4	D
SCI	15PHY100/ 15CHY100	Physics / Chemistry	3 0 0	3	C
SCI	15PHY181/ 15CHY181	Physics Lab. / Chemistry Lab.	0 0 2	1	L1
ENGG	15MEC180/ 15EEE180	Workshop A/ Workshop B	0 0 2	1	L2
ENGG	15MEC100	Engineering Drawing - CAD	2 0 2	3	E
HUM	15CUL101	Cultural Education I	2 0 0	2	F
			Total	**20**	

Semester II

Cat.	Code	Course Title	L-T-P	Cr	ES
SCI	15MAT121	Vector Calculus and Ordinary Differential Equations	3 1 0	4	B
SCI	15CHY100/ 15PHY100	Chemistry/ Physics	3 0 0	3	C
ENGG	15CSE102	Computer Programming	3 0 0	3	D
ENGG	15MEC102	Engineering Mechanics	3 0 0	3	E
ENGG	15AES111	Introduction to Aerospace Technology	3 0 0	3	A
SCI	15CHY181/ 15PHY181	Chemistry Lab. / Physics Lab.	0 0 2	1	L1
ENGG	15EEE180/ 15MEC180	Workshop B/ Workshop A	0 0 2	1	L2
ENGG	15CSE180	Computer Programming Lab.	0 0 2	1	L3
HUM	15CUL111	Cultural Education II	2 0 0	2	F
			Total	**21**	

Aerospace Engg. ..... Contd.

Semester III

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15AES201	Mechanics of Fluids	3 1 0	4	A
ENGG	15AES202	Introduction to Thermodynamics	2 1 0	3	C
ENGG	15AES203	Mechanics of Materials	2 1 0	3	D
ENGG	15AES204	Materials for Aviation and Space	3 0 0	3	E
SCI	15MAT204	Transforms and Partial Differential Equations	2 1 0	3	B
SCI		Science Elective I	2 1 0	3	G
HUM		Humanities Elective I		2	H
ENGG	15AES281	Measurement and Instrumentation Lab.[@]	0 0 2	1	L1
HUM	15AVP201	Amrita Values Programme I	1 0 0	1	F
			Total	**23**	

Semester IV

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15AES211	Aerodynamics I	3 0 0	3	A
ENGG	15AES212	Compressible Fluid Flow	2 1 0	3	C
ENGG	15AES213	Aerospace Structures I	3 0 0	3	D
ENGG	15AES214	Introduction to Control Theory	2 1 0	3	E
SCI	15MAT211	Calculus of Variations and Numerical Methods	2 1 0	3	B
HUM		Humanities Elective II		2	H
ENGG	15AES285	Mechanics of Fluids Lab.	0 0 2	1	L1
ENGG	15AES286	Materials Testing Lab.[@]	0 0 2	1	L2
HUM	15SSK221	Soft Skills I	1 0 2	2	G
HUM	15AVP211	Amrita Values Programme II	1 0 0	1	F
			Total	**22**	

[@] 'Hands-on' Project-based Lab.

Aerospace Engg. ..... Contd.

Semester V

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15AES301	Aerodynamics II	2 1 0	3	A
ENGG	15AES302	Aerospace Propulsion	2 1 0	3	C
ENGG	15AES303	Aerospace Structures II	3 0 0	3	D
ENGG	15AES304	Avionics	3 0 0	3	F
SCI	15MAT202	Linear Algebra	2 1 0	3	B
ENGG		Elective I*	3 0 0	3	E
ENGG	15AES381	Aero-structures Lab.@	0 0 2	1	L1
ENGG	15AES382	Avionics Lab.@	0 0 2	1	L2
HUM	15SSK321	Soft Skills II	1 0 2	2	G
ENGG	15AES390	Live-in-Lab**		[3]	P2
			Total	**22 [+3]**	

Semester VI

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15AES311	Finite Element Methods for Aerospace	2 1 0	3	A
ENGG	15AES312	Flight Mechanics	2 1 0	3	B
HUM	15ENV300	Environmental Science and Sustainability	3 0 0	3	C
ENGG		Elective II*	3 0 0	3	E
SCI		Science Elective II	3 0 0	3	H
ENGG	15AES383	Propulsion Lab.@	0 0 2	1	L1
ENGG	15AES384	Low-speed Aerodynamics Lab.@	0 0 2	1	L2
ENGG	15AES385	Innovations Lab.	0 0 2	1	L3
HUM	15SSK331	Soft Skills III	1 0 2	2	G
			Total	**20**	

@ 'Hands-on' Project-based Lab.

* A maximum of One Elective course can be chosen from the Electives prescribed for other Branches or from under Science Electives.

** Students undertaking and registering for a Live-in-Lab project, can be exempted from registering for an Elective course in the higher semester.

Aerospace Engg. ..... Contd.

Semester VII

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15AES401	Computational Fluid Dynamics for Aerospace	2 1 0	3	A
ENGG	15AES402	Aero Design	2 2 2	5	B
ENGG	15AES403	Flight Dynamics and Control	3 0 0	3	C
ENGG		Elective III*	3 0 0	3	E
ENGG		Elective IV*	3 0 0	3	D
ENGG	15AES481	UAV Lab.@	0 0 2	1	L1
PRJ	15AES495	Project Phase I		2	P1
ENGG	15AES490	Live-in-Lab**		[3]	P2
			Total	**20 [+3]**	

Semester VIII

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG		Elective V*	3 0 0	3	E
ENGG		Elective VI*	3 0 0	3	D
PRJ	15AES499	Project Phase II		10	P
			Total	**16**	
			TOTAL	**164**	

@ 'Hands-on' Project-based Lab.

* A maximum of One Elective course can be chosen from the Electives prescribed for other Branches or from under Science Electives.

** Students undertaking and registering for a Live-in-Lab project, can be exempted from registering for an Elective course in the higher semester.

Aerospace Engg. ..... Contd.

ELECTIVES

Elective I

15AES332 Fundamentals of Heat Transfer
15AES352 Vibration Analysis
15AES372 Manufacturing Processes

Elective II

15AES342 Experimental Aerodynamics
15AES353 Composite Materials and Mechanics
15AES373 Advanced Avionics

Elective III

15AES432 Air Breathing Engines
15AES452 Engineering Fracture Mechanics
15AES462 Helicopter Theory

Elective VI

15AES430 Rocket and Spacecraft Propulsion (O)
15AES442 Hypersonic Flow Theory
15AES453 Aero-Elasticity
15AES454 Advanced Composite Structures
15AES470 State Space Techniques (O)

Elective V

15AES440 Turbulent Flows (O)
15AES460 Space Flight Mechanics (O)
15AES471 Multidisciplinary Design Optimization (O)

Elective VI

15AES441 Advanced Computational Fluid Dynamics (O)
15AES450 Surface Engineering, Coating and Joining Technologies (O)
15AES461 Principles of Airport Management (O)

(O) *indicates Open electives which can be taken by students of other branches.*

CHEMICAL ENGINEERING

Semester I

Cat.	Code	Course Title	L-T-P	Cr	ES
HUM	15ENG111	Communicative English	2 0 2	3	A
SCI	15MAT111	Calculus and Matrix Algebra	2 1 0	3	B
ENGG	15CSE100	Computational Thinking and Problem Solving	3 0 2	4	D
SCI	15PHY100/ 15CHY100	Physics / Chemistry	3 0 0	3	C
SCI	15PHY181/ 15CHY181	Physics Lab. / Chemistry Lab.	0 0 2	1	L1
ENGG	15MEC180/ 15EEE180	Workshop A/ Workshop B	0 0 2	1	L2
ENGG	15MEC100	Engineering Drawing - CAD	2 0 2	3	E
HUM	15CUL101	Cultural Education I	2 0 0	2	F
			Total	**20**	

Semester II

Cat.	Code	Course Title	L-T-P	Cr	ES
SCI	15MAT121	Vector Calculus and Ordinary Differential Equations	3 1 0	4	B
SCI	15CHY100/ 15PHY100	Chemistry/ Physics	3 0 0	3	C
ENGG	15CSE102	Computer Programming	3 0 0	3	D
ENGG	15CHE111	Introduction to Chemical Engineering	3 0 0	3	A
ENGG	15CHE112	Material Balances	3 1 0	4	E
SCI	15CHY181/ 15PHY181	Chemistry Lab. / Physics Lab.	0 0 2	1	L1
ENGG	15EEE180/ 15MEC180	Workshop B/ Workshop A	0 0 2	1	L2
ENGG	15CSE180	Computer Programming Lab.	0 0 2	1	L3
HUM	15CUL111	Cultural Education II	2 0 0	2	F
			Total	**22**	

Chemical Engg. ..... Contd.

Semester III

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15CHE201	Energy Balance and Thermodynamics	3 0 2	4	A
ENGG	15CHE202	Fluid Mechanics	3 1 0	4	C
ENGG	15CHE203	Mechanical Operations	3 0 0	3	D
SCI	15CHY245	Instrumental Methods of Analysis	3 0 0	3	E
SCI	15MAT204	Transforms and Partial Differential Equations	2 1 0	3	B
HUM		Humanities Elective I		2	H
ENGG	15CHE281	Fluid Mechanics Lab.	0 0 2	1	L1
ENGG	15CHE282	Mechanical Operations Lab.	0 0 2	1	L2
HUM	15AVP201	Amrita Values Programme I	1 0 0	1	F
			Total	**22**	

Semester IV

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15CHE211	Chemical Engineering Thermodynamics	3 0 0	3	A
ENGG	15CHE212	Chemical Technology	4 0 0	4	B
ENGG	15CHE213	Process Heat Transfer	3 1 0	4	C
SCI		Science Elective	3 0 0	3	D
HUM		Humanities Elective II		2	H
ENGG	15CHE285	Chemical Engineering Instrumentation Lab.	1 0 2	2	L1
ENGG	15CHE286	Chemical Technology Lab.	0 0 2	1	L2
HUM	15SSK221	Soft Skills I	1 0 2	2	G
HUM	15AVP211	Amrita Values Programme II	1 0 0	1	F
			Total	**22**	

Chemical Engg. ..... Contd.

Semester V

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15CHE301	Chemical Reaction Engineering I	3 0 0	3	A
ENGG	15CHE302	Diffusional Mass Transfer Operations	3 1 0	4	C
ENGG	15CHE303	Statics and Strength of Materials	3 1 0	4	E
HUM	15ENV300	Environmental Science and Sustainability	3 0 0	3	D
SCI	15MAT214	Probability and Statistics	2 1 0	3	B
ENGG	15CHE381	Heat Transfer Lab.	0 0 2	1	L1
ENGG	15CHE382	Strength of Materials Lab.	0 0 2	1	L2
HUM	15SSK321	Soft Skills II	1 0 2	2	G
PRJ	15CHE391	Project Based Learning - Phase I		1	P1
ENGG	15CHE390	Live-in-Lab**		[3]	P2
			Total	**22 [+3]**	

Semester VI

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15CHE311	Chemical Reaction Engineering II	3 0 0	3	A
ENGG	15CHE312	Equilibrium Staged Operations	3 1 0	4	C
ENGG	15CHE313	Materials Technology	3 0 0	3	D
ENGG	15CHE314	Process Dynamics and Control	3 1 0	4	E
SCI	15MAT302	Numerical Methods	2 0 2	3	B
ENGG	15CHE385	Chemical Reaction Engineering Lab.	0 0 2	1	L1
ENGG	15CHE386	Mass Transfer Lab.	0 0 2	1	L2
HUM	15SSK331	Soft Skills III	1 0 2	2	G
PRJ	15CHE396	Project Based Learning – Phase II		2	P1
			Total	**23**	

** Students undertaking and registering for a Live-in-Lab project, can be exempted from registering for an Elective course in the higher semester.

Semester VII

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15CHE401	Process Design and Integration	3 0 0	3	A
ENGG	15CHE402	Process Equipment Design and Drawing	2 0 2	3	B
ENGG	15CHE403	Transport Phenomena	3 1 0	4	C
ENGG		Elective I*	3 0 0	3	E
HUM		Management Elective	3 0 0	3	D
ENGG	15CHE481	Chemical Process Control Lab.	0 0 2	1	L1
ENGG	15CHE482	Computer Aided Design Lab.	1 0 2	2	L2
PRJ	15CHE495	Project Phase I		2	P1
ENGG	15CHE490	Live-in-Lab**		[3]	P2
			Total	**21 [+3]**	

Semester VIII

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG		Elective II*	3 0 0	3	E
ENGG		Elective III*	3 0 0	3	D
PRJ	15CHE499	Project Phase II		10	P
			Total	**16**	
			TOTAL	**168**	

* A maximum of One Elective course can be chosen from the Electives prescribed for other Branches or from under Science Electives.

** Students undertaking and registering for a Live-in-Lab project, can be exempted from registering for an Elective course in the higher semester.

ELECTIVES

15CHY232	Biomaterials Science
15CHY244	Green Chemistry and Technology
15CHE431	Biochemical Engineering
15CHE432	Chemical Process Modelling and Simulation
15CHE433	Environmental Engineering for Process Industries
15CHE434	Interfacial Science and Engineering
15CHE435	Material Characterization and Spectroscopic Methods
15CHE436	Modern Separation Methods
15CHE437	Nanoscience and Nanotechnology
15CHE438	Petroleum Refining and Petrochemical Technology
15CHE439	Polymer Composites
15CHE440	Polymer Materials – Structure Property Relations
15CHE441	Polymer Processing
15CHE442	Process Instrumentation
15CHE443	Process Intensification
15CHE444	Safety and Hazard Management in Chemical Industries
15CHE445	Solar Energy

MANAGEMENT ELECTIVES

15CHE470	Fundamentals of Management
15CHE471	Managerial Economics and Accounting
15CHE472	Project Engineering of Process Plants

CIVIL ENGINEERING

Semester I

Cat.	Code	Course Title	L-T-P	Cr	ES
HUM	15ENG111	Communicative English	2 0 2	3	A
SCI	15MAT111	Calculus and Matrix Algebra	2 1 0	3	B
ENGG	15CSE100	Computational Thinking and Problem Solving	3 0 2	4	D
SCI	15PHY100/ 15CHY100	Physics / Chemistry	3 0 0	3	C
SCI	15PHY181/ 15CHY181	Physics Lab. / Chemistry Lab.	0 0 2	1	L1
ENGG	15MEC180/ 15EEE180	Workshop A/ Workshop B	0 0 2	1	L2
ENGG	15MEC100	Engineering Drawing - CAD	2 0 2	3	E
HUM	15CUL101	Cultural Education I	2 0 0	2	F
			Total	**20**	

Semester II

Cat.	Code	Course Title	L-T-P	Cr	ES
SCI	15MAT121	Vector Calculus and Ordinary Differential Equations	3 1 0	4	B
SCI	15CHY100/ 15PHY100	Chemistry/ Physics	3 0 0	3	C
ENGG	15CVL111	Introduction to Civil Engineering	1 0 0	1	A
ENGG	15CVL102	Mechanics: Statics and Dynamics	2 1 0	3	E
ENGG	15CSE102	Computer Programming	3 0 0	3	D
ENGG	15CSE180	Computer Programming Lab.	0 0 2	1	L3
ENGG	15CVL112	Engineering Graphics - CAD	1 0 2	2	G
SCI	15CHY181/ 15PHY181	Chemistry Lab. / Physics Lab.	0 0 2	1	L1
ENGG	15EEE180/ 15MEC180	Workshop B/ Workshop A	0 0 2	1	L2
HUM	15CUL111	Cultural Education II	2 0 0	2	F
			Total	**21**	

Civil Engg. ..... Contd.

Semester III

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15CVL201	Construction Materials	3 0 0	3	A
ENGG	15CVL202	Principles of Fluid Mechanics	2 1 0	3	C
ENGG	15CVL203	Solid Mechanics	3 1 0	4	D
ENGG	15CVL204	Surveying	3 1 0	4	G
SCI	15MAT204	Transforms and Partial Differential Equations	2 1 0	3	B
HUM		Humanities Elective I		2	H
ENGG	15CVL281	Material Testing Lab.	0 0 2	1	L1
ENGG	15CVL282	Survey Practice	1 0 2	2	L2
HUM	15 AVP201	Amrita Values Programme I	1 0 0	1	F
			Total	**23**	

Semester IV

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15CVL211	Building Technology	3 0 0	3	A
ENGG	15CVL212	Geology and Soil Mechanics	2 1 0	3	C
ENGG	15CVL213	Hydraulic Engineering	2 1 0	3	D
ENGG	15CVL214	Structural Analysis	2 1 0	3	E
SCI	15MAT212	Complex Analysis and Numerical Methods	2 1 0	3	B
HUM		Humanities Elective II		2	H
ENGG	15CVL285	Construction Materials Lab.	0 0 2	1	L1
ENGG	15CVL286	Hydraulic Engineering Lab.	0 0 2	1	L2
HUM	15SSK221	Soft Skills I	1 0 2	2	G
HUM	15AVP211	Amrita Values Programme II	1 0 0	1	F
			Total	**22**	

Semester V

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15CVL301	Advanced Structural Analysis	2 1 0	3	A
ENGG	15CVL302	Design of Concrete Structures	3 1 0	4	C
ENGG	15CVL303	Geotechnical Engineering	3 1 0	4	E
HUM	15ENV300	Environmental Science and Sustainability	3 0 0	3	D
SCI	15MAT214	Probability and Statistics	2 1 0	3	B
ENGG	15CVL381	Building Drawing	1 0 2	2	L2
ENGG	15CVL382	Geotechnical Engineering Lab.	0 0 2	1	L1
HUM	15SSK321	Soft Skills II	1 0 2	2	G
ENGG	15CVL390	Live-in-Lab**		[3]	P2
			Total	**22 [+3]**	

Semester VI

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15CVL311	Design of Steel Structures	3 1 0	4	A
ENGG	15CVL312	Environmental Engineering I	2 1 0	3	B
ENGG	15CVL385	Environmental Engineering Lab.	0 0 2	1	L1
ENGG	15CVL386	Estimation and Valuation Practice	1 0 2	2	L2
ENGG	15CVL313	Transportation Engineering I	2 1 0	3	C
ENGG	15CVL314	Water Resources and Irrigation Engineering	3 1 0	4	D
SCI		Science Elective	2 1 0	3	H
HUM	15SSK331	Soft Skills III	1 0 2	2	G
			Total	**22**	

** Students undertaking and registering for a Live-in-Lab project, can be exempted from registering for an Elective course in the higher semester.

Semester VII

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15CVL401	Construction Management	3 1 0	4	A
ENGG	15CVL402	Environmental Engineering II	2 1 0	3	B
ENGG	15CVL481	Structural Design and Detailing	0 0 2	1	L1
ENGG	15CVL403	Transportation Engineering II	2 1 0	3	C
ENGG		Elective I	2 1 0	3	E
ENGG		Elective II	2 1 0	3	D
PRJ	15CVL491	Professional Project	0 1 2	2	P2
PRJ	15CVL495	Project Phase I		2	P1
ENGG	15CVL490	Live-in-Lab**		[3]	P3
			Total	**21 [+3]**	

Semester VIII

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG		Elective III	2 1 0	3	E
ENGG		Elective IV / Open Elective*	2 1 0	3	D
PRJ	15CVL499	Project Phase II		10	P
			Total	**16**	
			TOTAL	**167**	

* A maximum of One Elective course can be chosen from the Electives prescribed for other Branches or from under Science Electives.

** Students undertaking and registering for a Live-in-Lab project, can be exempted from registering for an Elective course in the higher semester.

Civil Engg. ..... Contd.

ELECTIVES

STRUCTURAL ENGINEERING

15CVL430 Advanced Concrete Design
15CVL431 Advanced Mechanics of Materials
15CVL432 Advanced Steel Design
15CVL433 Bridge Engineering
15CVL434 Computer Methods of Structural Analysis
15CVL435 Finite Element Methods
15CVL436 Industrial Structures
15CVL437 Smart Materials and Structures
15CVL438 Structural Dynamics and Seismic Design

CONSTRUCTION TECHNOLOGY AND MANAGEMENT

15CVL440 Advanced Surveying
15CVL441 Architectural Science
15CVL442 Concrete Technology
15CVL443 Construction Economics and Finance
15CVL444 Distress Monitoring and Repair of Structures
15CVL445 Sustainable Construction

GEOTECHNICAL ENGINEERING

15CVL450 Advanced Foundation Engineering
15CVL451 Earth Retaining Structures
15CVL452 Environmental Geotechnology
15CVL453 Ground Improvement Techniques

WATER RESOURCES ENGINEERING

15CVL455 Ground Water Hydrology
15CVL456 Remote Sensing and GIS
15CVL457 Surface Water Hydrology and Hydro Power
15CVL458 Water Resources System Planning and Design

ENVIRONMENTAL ENGINEERING

15CVL460 Advanced Environmental Engineering
15CVL461 Environmental Impact Assessment
15CVL462 Industrial Waste Treatment

TRANSPORTATION ENGINEERING

15CVL470 Pavement Design
15CVL471 Traffic Engineering and Management
15CVL472 Transportation System Management and Control
15CVL473 Urban Transportation Planning

COMPUTER SCIENCE AND ENGINEERING

Semester I

Cat.	Code	Course Title	L-T-P	Cr	ES
HUM	15ENG111	Communicative English	2 0 2	3	A
SCI	15MAT111	Calculus and Matrix Algebra	2 1 0	3	B
ENGG	15CSE100	Computational Thinking and Problem Solving	3 0 2	4	D
SCI	15PHY100/ 15CHY100	Physics / Chemistry	3 0 0	3	C
SCI	15PHY181/ 15CHY181	Physics Lab. / Chemistry Lab.	0 0 2	1	L1
ENGG	15MEC180/ 15EEE180	Workshop A/ Workshop B	0 0 2	1	L2
ENGG	15MEC100	Engineering Drawing - CAD	2 0 2	3	E
HUM	15CUL101	Cultural Education I	2 0 0	2	F
			Total	**20**	

Semester II

Cat.	Code	Course Title	L-T-P	Cr	ES
SCI	15MAT121	Vector Calculus and Ordinary Differential Equations	3 1 0	4	B
SCI	15CHY100/ 15PHY100	Chemistry/ Physics	3 0 0	3	C
ENGG	15CSE102	Computer Programming	3 0 0	3	D
ENGG	15CSE111	Computer Science Essentials	3 0 0	3	E
ENGG	15EEE111	Fundamentals of Electrical and Electronics Engineering	4 0 0	4	A
SCI	15CHY181/ 15PHY181	Chemistry Lab. / Physics Lab.	0 0 2	1	L1
ENGG	15EEE180/ 15MEC180	Workshop B/ Workshop A	0 0 2	1	L2
ENGG	15CSE180	Computer Programming Lab.	0 0 2	1	L3
HUM	15CUL111	Cultural Education II	2 0 0	2	F
			Total	**22**	

Semester III

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15CSE201	Data Structures and Algorithms	3 1 0	4	A
ENGG	15CSE202	Object Oriented Programming	3 0 0	3	D
ENGG	15ECE202	Digital Circuits and Systems	3 1 0	4	C
SCI	15MAT201	Discrete Mathematics	3 1 0	4	B
HUM		Humanities Elective I		2	H
ENGG	15CSE281	Data Structures Lab.	0 0 2	1	L3
ENGG	15CSE282	Object Oriented Programming Lab.	0 0 2	1	L2
ENGG	15ECE281	Digital Circuits and Systems Lab.	0 0 2	1	L1
HUM	15AVP201	Amrita Values Programme I	1 0 0	1	F
			Total	**21**	

Semester IV

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15CSE211	Design and Analysis of Algorithms	3 1 0	4	A
ENGG	15CSE212	Introduction to Embedded Systems	3 0 0	3	C
ENGG	15CSE213	Operating Systems	3 1 0	4	D
SCI	15MAT213	Probability and Random Processes	3 1 0	4	B
ENGG	15CSE285	Embedded Systems Lab.	0 0 2	1	L1
ENGG	15CSE286	Operating Systems Lab.	0 0 2	1	L2
HUM		Humanities Elective II		2	H
HUM	15SSK221	Soft Skills I	1 0 2	2	G
HUM	15AVP211	Amrita Values Programme II	1 0 0	1	F
			Total	**22**	

Semester V

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15CSE301	Computer Organization and Architecture	3 0 0	3	A
ENGG	15CSE302	Database Management Systems	2 0 2	3	B
ENGG	15CSE303	Theory of Computation	3 0 0	3	C
HUM	15ENV300	Environmental Science and Sustainability	3 0 0	3	D
SCI	15MAT301	Linear Algebra, Queueing Theory and Optimization	3 1 0	4	B
ENGG		Elective I*	3 0 0	3	E
ENGG	15CSE381	Computer Organization and Architecture Lab.	0 0 2	1	L1
HUM	15SSK321	Soft Skills II	1 0 2	2	G
ENGG	15CSE390	Live-in-Lab**		[3]	P2
			Total	**22 [+3]**	

Semester VI

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15CSE311	Compiler Design	3 1 0	4	A
ENGG	15CSE312	Computer Networks	3 0 0	3	B
ENGG	15CSE313	Software Engineering	2 0 2	3	C
ENGG		Elective II*	3 0 0	3	E
ENGG		Elective III*	3 0 0	3	D
ENGG	15CSE385	Compiler Design Lab.	0 0 2	1	L1
ENGG	15CSE386	Computer Networks Lab.	0 0 2	1	L2
ENGG	15CSE387	Open Lab.	0 1 2	2	L3
HUM	15SSK331	Soft Skills III	1 0 2	2	G
			Total	**22**	

* A maximum of One Elective course can be chosen from the Electives prescribed for other Branches or from under Science Electives.

** Students undertaking and registering for a Live-in-Lab project, can be exempted from registering for an Elective course in the higher semester.

Semester VII

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15CSE401	Machine Learning and Data Mining	3 0 0	3	A
ENGG	15CSE402	Structure and Interpretation of Computer Programs	3 1 0	4	B
ENGG		Elective IV*	3 0 0	3	E
ENGG		Elective V*	3 0 0	3	D
ENGG		Project Based Elective	2 0 2	3	C
ENGG	15CSE481	Machine Learning and Data Mining Lab.	0 0 2	1	L1
PRJ	15CSE495	Project Phase I		2	P1
ENGG	15CSE490	Live-in-Lab**		[3]	P2
			Total	**19 [+3]**	

Semester VIII

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15CSE411	Software Project Management	3 0 0	3	A
ENGG		Elective VI*	3 0 0	3	E
PRJ	15CSE499	Project Phase II		10	P
			Total	**16**	
			TOTAL	**164**	

* A maximum of One Elective course can be chosen from the Electives prescribed for other Branches or from under Science Electives.

** Students undertaking and registering for a Live-in-Lab project, can be exempted from registering for an Elective course in the higher semester.

ELECTIVES (3 0 0 3)

15CSE330	Information Technology Essentials
15CSE331	Advanced Algorithms and Analysis
15CSE332	Advanced Computer Architecture
15CSE334	Big Data Analytics
15CSE335	Bioinformatics
15CSE336	Biometrics
15CSE337	Cloud Computing and Services
15CSE338	Computational Intelligence
15CSE339	Computer Systems Engineering
15CSE340	Computer Vision
15CSE341	Cryptography
15CSE342	Data Compression
15CSE343	Design Patterns
15CSE344	Digital Watermarking
15CSE345	Distributed Embedded Systems
15CSE347	Enterprise Architecture
15CSE349	Information Coding Techniques
15CSE350	Information Retrieval
15CSE351	Information Security
15CSE352	Intelligent Systems
15CSE353	Introduction to Intellectual Property Rights
15CSE355	Modelling and Simulation
15CSE358	Natural Language Processing
15CSE360	Parallel and Distributed Computing
15CSE361	Pattern Recognition
15CSE362	Pervasive Computing
15CSE363	Principles of Digital Image Processing
15CSE364	Real-Time Computing Systems
15CSE365	Scientific Computing
15CSE366	Semantic Web
15CSE367	Service-oriented Architecture

C.S. Engg. ..... Contd.

15CSE368	Software Quality Assurance
15CSE369	Spatiotemporal Data Management
15CSE370	Wireless and Mobile Communication
15CSE371	Wireless and Mobile Computing
15CSE372	Wireless Sensor Networks

PROJECT-BASED ELECTIVES (2 0 2 3)

15CSE333	Advanced Database Management Systems
15CSE346	Embedded Programming
15CSE348	Human Computer Interface
15CSE356	Multimedia Databases
15CSE357	Nand2tetris: Building Computers from First Principles
15CSE359	OS for Smart Devices (Android and IOS)
15CSE376	Net Centric Programming

ELECTRONICS AND COMMUNICATION ENGINEERING

Semester I

Cat.	Code	Course Title	L-T-P	Cr	ES
HUM	15ENG111	Communicative English	2 0 2	3	A
SCI	15MAT111	Calculus and Matrix Algebra	2 1 0	3	B
ENGG	15CSE100	Computational Thinking and Problem Solving	3 0 2	4	D
SCI	15PHY100/ 15CHY100	Physics / Chemistry	3 0 0	3	C
SCI	15PHY181/ 15CHY181	Physics Lab. / Chemistry Lab.	0 0 2	1	L1
ENGG	15MEC180/ 15EEE180	Workshop A/ Workshop B	0 0 2	1	L2
ENGG	15MEC100	Engineering Drawing - CAD	2 0 2	3	E
HUM	15CUL101	Cultural Education I	2 0 0	2	F
			Total	**20**	

Semester II

Cat.	Code	Course Title	L-T-P	Cr	ES
SCI	15MAT121	Vector Calculus and Ordinary Differential Equations	3 1 0	4	B
SCI	15CHY100/ 15PHY100	Chemistry/ Physics	3 0 0	3	C
ENGG	15CSE102	Computer Programming	3 0 0	3	D
ENGG	15ECE111	Solid State Devices	3 0 0	3	E
ENGG	15ECE112	Fundamentals of Electrical Technology	3 1 0	4	A
SCI	15CHY181/ 15PHY181	Chemistry Lab. / Physics Lab.	0 0 2	1	L1
ENGG	15EEE180/ 15MEC180	Workshop B/ Workshop A	0 0 2	1	L2
ENGG	15CSE180	Computer Programming Lab.	0 0 2	1	L3
HUM	15CUL111	Cultural Education II	2 0 0	2	F
			Total	**22**	

E C Engg. ..... Contd.

Semester III

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15ECE201	Applied Electromagnetics	3 1 0	4	A
ENGG	15ECE202	Digital Circuits and Systems	3 1 0	4	C
ENGG	15ECE203	Network Theory	3 0 0	3	D
ENGG	15ECE204	Signal Processing I	3 1 0	4	E
SCI	15MAT202	Linear Algebra	2 1 0	3	B
HUM		Humanities Elective I		2	H
ENGG	15ECE281	Digital Circuits and Systems Lab.	0 0 2	1	L1
ENGG	15ECE282	Signal Processing I Lab.	0 0 2	1	L2
HUM	15AVP201	Amrita Values Programme I	1 0 0	1	F
			Total	**23**	

Semester IV

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15ECE211	Electronic Circuits	3 1 0	4	A
ENGG	15ECE212	Signal Processing II	3 1 0	4	C
ENGG	15ECE213	Transmission Lines and Waveguides	3 0 0	3	D
SCI	15MAT213	Probability and Random Processes	3 1 0	4	B
HUM		Humanities Elective II		2	H
ENGG	15ECE285	Digital Signal Processing Lab.	0 0 2	1	L1
ENGG	15ECE286	Electronic Circuits Lab.	0 0 2	1	L2
HUM	15SSK221	Soft Skills I	1 0 2	2	G
HUM	15AVP211	Amrita Values Programme II	1 0 0	1	F
			Total	**22**	

E C Engg. ..... Contd.

Semester V

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15ECE301	Communication Theory	3 1 0	4	A
ENGG	15ECE302	Control Systems Engineering	3 1 0	4	C
ENGG	15ECE303	Linear Integrated Circuits	3 0 0	3	D
ENGG	15ECE304	Microprocessor and Microcontroller	3 1 0	4	E
SCI	15MAT303	Optimization Techniques	2 1 0	3	B
ENGG	15ECE381	Circuits and Communication Lab.	0 0 2	1	L1
ENGG	15ECE382	Microcontroller Lab.	0 0 2	1	L2
HUM	15SSK321	Soft Skills II	1 0 2	2	G
ENGG	15ECE390	Live-in-Lab**		[3]	P2
			Total	**22 [+3]**	

Semester VI

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15ECE311	Data Communication and Networks	3 0 0	3	A
ENGG	15ECE312	Digital Communication	3 1 0	4	B
ENGG	15ECE313	VLSI Design	3 0 0	3	C
ENGG	15ECE314	Computer System Architecture	3 0 0	3	D
ENGG		Elective I*	3 0 0	3	E
ENGG	15ECE385	Digital Communication Lab.	0 0 2	1	L1
ENGG	15ECE386	VLSI Design Lab.	0 0 2	1	L2
ENGG	15ECE387	Open Lab.	0 1 2	2	L3
HUM	15SSK331	Soft Skills III	1 0 2	2	G
			Total	**22**	

* A maximum of One Elective course can be chosen from the Electives prescribed for other Branches or from under Science Electives.

** Students undertaking and registering for a Live-in-Lab project, can be exempted from registering for an Elective course in the higher semester.

E C Engg. ..... Contd.

Semester VII

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15ECE401	Information Theory and Coding Techniques	3 1 0	4	A
ENGG	15ECE402	Radio Frequency Engineering	3 1 0	4	B
HUM	15ENV300	Environmental Science and Sustainability	3 0 0	3	H
ENGG		Elective II*	3 0 0	3	E
ENGG		Elective III*	3 0 0	3	D
ENGG	15ECE481	Microwave Engineering Lab.	0 0 2	1	L1
PRJ	15ECE495	Project Phase I		2	P1
ENGG	15ECE490	Live-in-Lab**		[3]	P2
			Total	**20 [+3]**	

Semester VIII

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG		Elective IV*	3 0 0	3	E
ENGG		Elective V*	3 0 0	3	D
PRJ	15ECE499	Project Phase II		10	P
			Total	**16**	
			TOTAL	**167**	

* A maximum of One Elective course can be chosen from the Electives prescribed for other Branches or from under Science Electives.

** Students undertaking and registering for a Live-in-Lab project, can be exempted from registering for an Elective course in the higher semester.

E C Engg. ..... Contd.

ELECTIVES

COMMUNICATION

15ECE344 Antenna Systems and Design
15ECE345 Cellular and Mobile Communication System
15ECE346 Digital Telephony
15ECE347 Introduction to Radar Systems
15ECE348 Microstrip Devices and Circuits
15ECE349 Microwave Solid State Devices
15ECE350 Millimeter Wave Personal Communication System
15ECE351 MIMO and Multicarrier Systems
15ECE352 Multimedia Communication Standards
15ECE353 Optical Communication
15ECE354 Principles of RFID Design
15ECE355 Radio Frequency Circuit Design
15ECE356 Satellite Communication
15ECE357 Software Defined Radio
15ECE358 Spread Spectrum Communication
15ECE359 Wireless Communication

COMPUTER SCIENCE ENGINEERING

15CSE313 Software Engineering
15CSE330 Information Technology Essentials
15CSE374 Introduction to Data Structures and Algorithms

ANALOG ELECTRONICS

15ECE315 Biomedical Instrumentation
15ECE337 Analog and Mixed Circuit Design
15ECE338 Analog IC Design
15ECE339 Applications of Linear Integrated Circuits
15ECE340 Integrated Circuits for Biological Systems

MANAGEMENT

15ECE376 Agent-Based Modelling
15ECE377 Econometrics
15ECE378 Financial Engineering
15ECE379 Signal Processing for Business Applications
15ECE380 Telecommunication Management

E C Engg. ..... Contd.

15MEC332	Enterprise Management
15MEC333	Financial Management
15MEC411	Operations Research

SIGNAL PROCESSING

15ECE320	Active Filter Design
15ECE321	Adaptive Signal Processing
15ECE322	Analog Signal Processing
15ECE323	Aviation Electronics
15ECE324	Biomedical Image Processing
15ECE325	Biomedical Signal Processing
15ECE326	Biometric Systems
15ECE327	Digital Signal Processors and Applications
15ECE328	Hyperspectral Imaging Analysis
15ECE329	Image Analysis
15ECE330	Image Processing
15ECE331	Pattern Recognition Techniques and Algorithms
15ECE332	Sparse Signal and Image Processing
15ECE333	Spoken Language Processing
15ECE334	Wavelet-based Signal Processing and Application

VLSI

15ECE363	Data Security
15ECE364	Digital IC Design
15ECE365	Electronic System Level Design and Verification
15ECE366	Embedded Systems
15ECE367	Hardware Security and Trust
15ECE368	Introduction to Soft Computing
15ECE369	Principles of VLSI Testing
15ECE370	RISC Processor Design using HDL
15ECE371	VLSI Fabrication Technology
15ECE372	VLSI Digital Signal Processing Systems
15ECE373	VLSI System Design

ELECTRICAL AND ELECTRONICS ENGINEERING

Semester I

Cat.	Code	Course Title	L-T-P	Cr	ES
HUM	15ENG111	Communicative English	2 0 2	3	A
SCI	15MAT111	Calculus and Matrix Algebra	2 1 0	3	B
ENGG	15CSE100	Computational Thinking and Problem Solving	3 0 2	4	D
SCI	15PHY100/ 15CHY100	Physics / Chemistry	3 0 0	3	C
SCI	15PHY181/ 15CHY181	Physics Lab. / Chemistry Lab.	0 0 2	1	L1
ENGG	15MEC180/ 15EEE180	Workshop A/ Workshop B	0 0 2	1	L2
ENGG	15MEC100	Engineering Drawing - CAD	2 0 2	3	E
HUM	15CUL101	Cultural Education I	2 0 0	2	F
			Total	**20**	

Semester II

Cat.	Code	Course Title	L-T-P	Cr	ES
SCI	15MAT121	Vector Calculus and Ordinary Differential Equations	3 1 0	4	B
SCI	15CHY100/ 15PHY100	Chemistry/ Physics	3 0 0	3	C
ENGG	15CSE102	Computer Programming	3 0 0	3	D
ENGG	15EEE111	Fundamentals of Electrical and Electronics Engineering	4 0 0	4	A
ENGG	15MEC111	Fundamentals of Mechanical Engineering	3 0 0	3	E
SCI	15CHY181/ 15PHY181	Chemistry Lab. / Physics Lab.	0 0 2	1	L1
ENGG	15EEE180/ 15MEC180	Workshop B/ Workshop A	0 0 2	1	L2
ENGG	15CSE180	Computer Programming Lab.	0 0 2	1	L3
HUM	15CUL111	Cultural Education II	2 0 0	2	F
			Total	**22**	

E E Engg. ..... Contd.

Semester III

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15EEE201	Analog Electronic Circuits	3 1 0	4	A
ENGG	15EEE202	Electric Circuits	3 1 0	4	D
ENGG	15EEE203	Electromagnetic Theory	3 1 0	4	C
SCI	15MAT203	Transforms and Complex Analysis	3 1 0	4	B
HUM		Humanities Elective I		2	H
ENGG	15EEE281	Electric Circuits Lab.	0 0 2	1	L2
ENGG	15EEE282	Electronic Circuits and Simulations Lab. I	0 0 2	1	L1
HUM	15AVP201	Amrita Values Programme I	1 0 0	1	F
			Total	**21**	

Semester IV

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15EEE211	Analog Integrated Circuits	3 0 0	3	A
ENGG	15EEE212	Electrical Machines I	3 1 0	4	C
ENGG	15EEE213	Electrical Measurements	3 0 0	3	D
SCI	15MAT214	Probability and Statistics	2 1 0	3	B
HUM		Humanities Elective II		2	H
ENGG	15EEE285	Electrical Machines Lab. I	0 0 2	1	L1
ENGG	15EEE286	Electrical Measurements Lab.	0 0 2	1	L2
ENGG	15EEE287	Electronic Circuits and Simulations Lab. II	0 0 2	1	L3
HUM	15SSK221	Soft Skills I	1 0 2	2	G
HUM	15AVP211	Amrita Values Programme II	1 0 0	1	F
			Total	**21**	

E E Engg. ..... Contd.

Semester V

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15EEE301	Control Systems	3 0 0	3	A
ENGG	15EEE302	Digital Systems	3 0 0	3	B
ENGG	15EEE303	Electrical Machines II	3 0 0	3	C
ENGG	15EEE304	Signals and Systems	3 0 0	3	E
HUM	15ENV300	Environmental Science and Sustainability	3 0 0	3	D
ENGG	15MEC305	Thermal Engineering and Fluid Machinery	3 0 0	3	F
ENGG	15EEE381	Digital Systems and Signals Lab.	0 0 2	1	L1
ENGG	15EEE382	Electrical Machines Lab. II	0 0 2	1	L2
HUM	15SSK321	Soft Skills II	1 0 2	2	G
ENGG	15EEE390	Live-in-Lab**		[3]	P2
			Total	**22 [+3]**	

Semester VI

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15EEE311	Digital Signal Processing	3 0 0	3	A
ENGG	15EEE312	Electrical Energy Systems I	3 0 0	3	C
ENGG	15EEE313	Power Electronics	3 0 0	3	D
ENGG	15EEE314	Microcontroller and Applications	3 0 0	3	F
SCI	15MAT303	Optimization Techniques	2 1 0	3	B
ENGG		Elective I*	3 0 0	3	E
ENGG	15EEE385	DSP and Microcontroller Lab.	0 0 2	1	L1
ENGG	15EEE386	Power Electronics Lab.	0 0 2	1	L2
ENGG	15EEE387	Open Lab.	0 1 2	2	L3
HUM	15SSK331	Soft Skills III	1 0 2	2	G
			Total	**24**	

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E E Engg. ..... Contd.

Semester VII

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15EEE401	Electric Drives and Control	3 1 0	4	A
ENGG	15EEE402	Electrical Energy Systems II	3 1 0	4	B
ENGG		Elective II*	3 0 0	3	E
ENGG		Elective III*	3 0 0	3	D
ENGG	15EEE481	Drives and Controls Lab.	0 0 2	1	L1
ENGG	15EEE482	Power Systems Lab.	0 0 2	1	L2
PRJ	15EEE495	Project Phase I		2	P1
ENGG	15EEE490	Live-in-Lab**		[3]	P2
			Total	**18 [+3]**	

Semester VIII

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG		Elective IV*	3 0 0	3	E
ENGG		Elective V*	3 0 0	3	D
PRJ	15EEE499	Project Phase II		10	P
			Total	**16**	

TOTAL 164

* A maximum of One Elective course can be chosen from the Electives prescribed for other Branches or from under Science Electives.

** Students undertaking and registering for a Live-in-Lab project, can be exempted from registering for an Elective course in the higher semester.

E E Engg. ..... Contd.

ELECTIVES

15EEE330	Advanced Control Systems
15EEE331	Advanced Microcontrollers
15EEE332	Communication Engineering
15EEE333	Deregulated Power System
15EEE334	Design of Electrical Apparatus
15EEE335	Design of Electrical Systems
15EEE336	Digital Control Systems
15EEE337	Digital Image Processing
15EEE338	Digital Signal Processors
15EEE339	Electrical Safety
15EEE340	Electromagnetic Compatibility
15EEE341	Embedded Systems Design
15EEE342	Flexible AC Transmission Systems
15EEE343	Fundamentals of Soft Computing
15EEE344	High Voltage Engineering
15EEE345	Illumination Engineering
15EEE346	Industrial Electronics
15EEE347	Introduction to Computer Networks
15EEE348	Management of Power Distribution
15EEE349	Network Synthesis
15EEE350	Optoelectronics and Laser Instrumentation
15EEE351	Power Converters
15EEE352	Power Plant Instrumentation
15EEE353	Power Quality
15EEE354	Power System Management
15EEE355	Power System Protection and Switchgear
15EEE356	Power System Stability
15EEE357	Power Systems Operation, Control and Stability
15EEE358	Process Control and Instrumentation
15EEE359	Renewable Energy and Energy Conservation
15EEE360	Smart Grid
15EEE361	Special Electric Machines
15EEE362	Utilisation of Electric Energy
15CSE301	Computer Organisation and Architecture
15CSE330	Information Technology Essentials
15CSE374	Introduction to Data Structures and Algorithms
15ECE315	Biomedical Instrumentation
15ECE373	VLSI System Design

ELECTRONICS AND INSTRUMENTATION ENGINEERING

Semester I

Cat.	Code	Course Title	L-T-P	Cr	ES
HUM	15ENG111	Communicative English	2 0 2	3	A
SCI	15MAT111	Calculus and Matrix Algebra	2 1 0	3	B
ENGG	15CSE100	Computational Thinking and Problem Solving	3 0 2	4	D
SCI	15PHY100/ 15CHY100	Physics / Chemistry	3 0 0	3	C
SCI	15PHY181/ 15CHY181	Physics Lab. / Chemistry Lab.	0 0 2	1	L1
ENGG	15MEC180/ 15EEE180	Workshop A/ Workshop B	0 0 2	1	L2
ENGG	15MEC100	Engineering Drawing - CAD	2 0 2	3	E
HUM	15CUL101	Cultural Education I	2 0 0	2	F
			Total	**20**	

Semester II

Cat.	Code	Course Title	L-T-P	Cr	ES
SCI	15MAT121	Vector Calculus and Ordinary Differential Equations	3 1 0	4	B
SCI	15CHY100/ 15PHY100	Chemistry/ Physics	3 0 0	3	C
ENGG	15CSE102	Computer Programming	3 0 0	3	D
ENGG	15ECE112	Fundamentals of Electrical Technology	3 1 0	4	A
ENGG	15ECE111	Solid State Devices	3 0 0	3	E
SCI	15CHY181/ 15PHY181	Chemistry Lab. / Physics Lab.	0 0 2	1	L1
ENGG	15EEE180/ 15MEC180	Workshop B/ Workshop A	0 0 2	1	L2
ENGG	15CSE180	Computer Programming Lab.	0 0 2	1	L3
HUM	15CUL111	Cultural Education II	2 0 0	2	F
			Total	**22**	

E I Engg. ..... Contd.

Semester III

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15EIE201	Industrial Instrumentation I	3 1 0	4	A
ENGG	15ECE202	Digital Circuits and Systems	3 1 0	4	C
ENGG	15EEE202	Electric Circuits	3 1 0	4	D
SCI	15MAT204	Transforms and Partial Differential Equations	2 1 0	3	B
ENGG	15MEC205	Fluid and Thermal Engineering	3 0 2	4	E
HUM		Humanities Elective I		2	H
ENGG	15EIE281	Industrial Instrumentation I Lab.	0 0 2	1	L2
ENGG	15ECE281	Digital Circuits and Systems Lab.	0 0 2	1	L1
HUM	15AVP201	Amrita Values Programme I	1 0 0	1	F
			Total	**24**	

Semester IV

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15EIE211	Electrical and Electronic Measurements	3 1 0	4	D
ENGG	15ECE204	Signal Processing I	3 1 0	4	C
ENGG	15ECE211	Electronic Circuits	3 1 0	4	A
SCI	15MAT212	Complex Analysis and Numerical Methods	2 1 0	3	B
HUM		Humanities Elective II		2	H
ENGG	15EIE285	Measurements Lab.	0 0 2	1	L1
ENGG	15ECE286	Electronic Circuits Lab.	0 0 2	1	L2
HUM	15SSK221	Soft Skills I	1 0 2	2	G
HUM	15AVP211	Amrita Values Programme II	1 0 0	1	F
			Total	**22**	

E I Engg. ..... Contd.

Semester V

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15EIE301	Electrical Machines	3 1 0	4	A
ENGG	15ECE212	Signal Processing II	3 1 0	4	E
ENGG	15ECE302	Control Systems Engineering	3 1 0	4	C
ENGG	15ECE303	Linear Integrated Circuits	3 0 0	3	D
SCI	15MAT214	Probability and Statistics	2 1 0	3	B
ENGG	15EIE381	Signal Processing Lab.	0 0 2	1	L2
ENGG	15ECE383	Linear Integrated Circuits Lab.	0 0 2	1	L1
HUM	15SSK321	Soft Skills II	1 0 2	2	G
ENGG	15EIE390	Live-in-Lab**		[3]	P2
			Total	**22**	**[+3]**

Semester VI

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15EIE311	Industrial Instrumentation II	3 0 0	3	A
ENGG	15EIE312	Process Control	3 0 0	3	B
ENGG	15ECE304	Microprocessor and Microcontroller	3 1 0	4	C
ENGG	15ECE315	Biomedical Instrumentation	3 0 0	3	D
ENGG		Elective I*	3 0 0	3	E
ENGG	15EIE385	Process Control Lab.	0 0 2	1	L1
ENGG	15ECE382	Microcontroller Lab.	0 0 2	1	L2
ENGG	15EIE386	Open Lab.	0 1 2	2	L3
HUM	15SSK331	Soft Skills III	1 0 2	2	G
			Total	**22**	

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** Students undertaking and registering for a Live-in-Lab project, can be exempted from registering for an Elective course in the higher semester.

E I Engg. ..... Contd.

Semester VII

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15EIE401	Data Acquisition and Communication	3 1 0	4	A
ENGG	15EIE402	Industrial Automation	3 1 0	4	B
ENGG	15EIE403	Power ElectronicDevices and Circuits	3 1 0	4	C
HUM	15ENV300	Environmental Science and Sustainability	3 0 0	3	D
ENGG		Elective II*	3 0 0	3	E
ENGG	15EIE481	Industrial Automation Lab.	0 0 2	1	L1
PRJ	15EIE495	Project Phase I		2	P1
ENGG	15EIE490	Live-in-Lab**		[3]	P2
			Total	**21**	**[+3]**

Semester VIII

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG		Elective III*	3 0 0	3	E
ENGG		Elective IV*	3 0 0	3	D
PRJ	15EIE499	Project Phase II		10	P
			Total	**16**	

TOTAL 169

* A maximum of One Elective course can be chosen from the Electives prescribed for other Branches or from under Science Electives.

** Students undertaking and registering for a Live-in-Lab project, can be exempted from registering for an Elective course in the higher semester.

ELECTIVES

SIGNAL PROCESSING

15ECE320	Active Filter Design
15ECE321	Adaptive Signal Processing
15ECE323	Aviation Electronics
15ECE324	Biomedical Image Processing
15ECE325	Biomedical Signal Processing
15ECE326	Biometric Systems
15ECE327	Digital Signal Processors and Applications
15ECE328	Hyperspectral Imaging Analysis
15ECE329	Image Analysis
15ECE330	Image Processing
15ECE331	Pattern Recognition Techniques and Algorithms
15ECE332	Sparse Signal and Image Processing
15ECE333	Spoken Language Processing
15ECE334	Wavelet-based Signal Processing and Application

VLSI / ANALOG ELECTRONICS

15ECE313	VLSI Design
15ECE337	Analog and Mixed Circuit Design
15ECE338	Analog IC Design
15ECE339	Applications of Linear Integrated Circuits
15ECE340	Integrated Circuits for Biological Systems
15ECE364	Digital IC Design
15ECE365	Electronic System Level Design and Verification
15ECE366	Embedded Systems
15ECE368	Introduction to Soft Computing
15ECE369	Principles of VLSI Testing
15ECE371	VLSI Fabrication Technology
15ECE373	VLSI System Design

COMPUTER SCIENCE

15CSE313	Software Engineering
15CSE330	Information Technology Essentials
15CSE374	Introduction to Data Structures and Algorithms
15ECE314	Computer System Architecture

INSTRUMENTATION AND CONTROL

15EIE330	Advanced Process Control
15EIE331	Digital Control and State Variable Methods
15EIE332	Embedded Systems for Instrumentation
15EIE333	Fibreoptics and Laser Instrumentation
15EIE334	Instrumentation Project Management and System Design
15EIE335	Intelligent Control Systems
15EIE336	Sensors and Signal Conditioning
15EIE337	Virtual Instrumentation

MANAGEMENT

15ECE376	Agent-based Modelling
15ECE377	Econometrics
15ECE378	Financial Engineering
15ECE379	Signal Processing for Business Applications
15MEC332	Enterprise Management
15MEC333	Financial Management
15MEC411	Operations Research

MECHANICAL ENGINEERING

Semester I

Cat.	Code	Course Title	L-T-P	Cr	ES
HUM	15ENG111	Communicative English	2 0 2	3	A
SCI	15MAT111	Calculus and Matrix Algebra	2 1 0	3	B
ENGG	15CSE100	Computational Thinking and Problem Solving	3 0 2	4	D
SCI	15PHY100/ 15CHY100	Physics / Chemistry	3 0 0	3	C
SCI	15PHY181/ 15CHY181	Physics Lab. / Chemistry Lab.	0 0 2	1	L1
ENGG	15MEC180/ 15EEE180	Workshop A/ Workshop B	0 0 2	1	L2
ENGG	15MEC100	Engineering Drawing - CAD	2 0 2	3	E
HUM	15CUL101	Cultural Education I	2 0 0	2	F
			Total	**20**	

Semester II

Cat.	Code	Course Title	L-T-P	Cr	ES
SCI	15MAT121	Vector Calculus and Ordinary Differential Equations	3 1 0	4	B
SCI	15CHY100/ 15PHY100	Chemistry/ Physics	3 0 0	3	C
ENGG	15CSE102	Computer Programming	3 0 0	3	D
ENGG	15MEC101	Engineering Drawing - CAD II	2 0 2	3	A
ENGG	15MEC102	Engineering Mechanics	3 0 0	3	E
SCI	15CHY181/ 15PHY181	Chemistry Lab. / Physics Lab.	0 0 2	1	L1
ENGG	15EEE180/ 15MEC180	Workshop B/ Workshop A	0 0 2	1	L2
ENGG	15CSE180	Computer Programming Lab.	0 0 2	1	L3
HUM	15CUL111	Cultural Education II	2 0 0	2	F
			Total	**21**	

Mechanical Engg. ..... Contd.

Semester III

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15MEC201	Engineering Thermodynamics	3 0 0	3	A
ENGG	15MEC202	Machine Drawing	2 0 2	3	C
ENGG	15MEC203	Material Science and Metallurgy	3 0 0	3	D
ENGG	15MEC204	Mechanics of Solids	3 0 0	3	E
ENGG	15EEE205	Electrical and Electronics Engineering	3 0 2	4	G
SCI	15MAT204	Transforms and Partial Differential Equations	2 1 0	3	B
HUM		Humanities Elective I		2	H
ENGG	15MEC281	Material Testing and Metallurgy Lab.	0 0 2	1	L1
HUM	15AVP201	Amrita Values Programme I	1 0 0	1	F
			Total	**23**	

Semester IV

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15MEC211	Fluid Mechanics and Machinery	4 0 0	4	A
ENGG	15MEC212	Kinematics of Machines	3 0 2	4	C
ENGG	15MEC213	Manufacturing Process I	3 0 0	3	D
SCI	15MAT214	Probability and Statistics	2 1 0	3	B
ENGG		Elective I*	3 0 0	3	E
HUM		Humanities Elective II		2	H
ENGG	15MEC285	Fluid Mechanics and Machines Lab.	0 0 2	1	L1
HUM	15SSK221	Soft Skills I	1 0 2	2	G
HUM	15AVP211	Amrita Values Programme II	1 0 0	1	F
			Total	**23**	

Mechanical Engg. ..... Contd.

Semester V

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15MEC301	Design of Machine Elements I	3 0 0	3	A
ENGG	15MEC302	Dynamics of Machines	3 0 0	3	C
ENGG	15MEC303	Heat Power Engineering	3 0 0	3	D
ENGG	15MEC304	Manufacturing Process II	3 0 0	3	F
SCI	15MAT302	Numerical Methods	2 0 2	3	B
ENGG		Elective II*	3 0 0	3	E
ENGG	15MEC381	Manufacturing Process Lab.	0 0 2	1	L1
ENGG	15MEC382	Thermal Science Lab.	0 0 2	1	L2
HUM	15SSK321	Soft Skills II	1 0 2	2	G
ENGG	15MEC390	Live-in-Lab**		[3]	P2
			Total	**22 [+3]**	

Semester VI

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15MEC311	Design of Machine Elements II	3 1 0	4	A
ENGG	15MEC312	Heat Transfer	3 1 0	4	B
ENGG	15MEC313	Introduction to Finite Element Methods	3 0 2	4	C
ENGG	15MEC314	Metrology and Measurements	3 0 0	3	D
ENGG		Elective III*	3 0 0	3	E
ENGG	15MEC385	Heat Transfer and Thermal Analysis Lab.	0 0 2	1	L1
ENGG	15MEC386	Metrology and Measurements Lab.	0 0 2	1	L2
HUM	15SSK331	Soft Skills III	1 0 2	2	G
			Total	**22**	

* A maximum of One Elective course can be chosen from the Electives prescribed for other Branches or from under Science Electives.

** Students undertaking and registering for a Live-in-Lab project, can be exempted from registering for an Elective course in the higher semester.

Mechanical Engg. ..... Contd.

Semester VII

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15MEC401	Advanced Fluid Mechanics	3 0 0	3	A
ENGG	15MEC402	Control Engineering	3 0 0	3	B
ENGG	15MEC403	Industrial Robotics	3 0 0	3	C
ENGG	15MEC404	Mechanical Vibrations	3 0 0	3	F
HUM	15ENV300	Environmental Science and Sustainability	3 0 0	3	D
ENGG		Elective IV*	3 0 0	3	E
ENGG	15MEC481	Computer Integrated Manufacturing Lab.	0 0 2	1	L1
ENGG	15MEC482	Machine Dynamics and Control Lab.	0 0 2	1	L2
PRJ	15MEC495	Project Phase I		2	P1
ENGG	15MEC490	Live-in-Lab**		[3]	P2
			Total	**22 [+3]**	

Semester VIII

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15MEC411	Operations Research	3 0 0	3	A
ENGG		Elective V*	3 0 0	3	E
PRJ	15MEC499	Project Phase II		10	P
			Total	**16**	
			TOTAL	**169**	

* A maximum of One Elective course can be chosen from the Electives prescribed for other Branches or from under Science Electives.

** Students undertaking and registering for a Live-in-Lab project, can be exempted from registering for an Elective course in the higher semester.

ELECTIVES

DESIGN STREAM

15MEC230 Aircraft Systems and Engineering
15MEC231 Automotive Chassis Design
15MEC232 Automotive Technology
15MEC233 Condition Monitoring and Diagnostic Maintenance
15MEC234 Design for Manufacture and Assembly
15MEC235 Fracture Mechanics
15MEC236 Materials Selection in Mechanical Design
15MEC237 Mechatronics
15MEC238 Micro-Electro Mechanical Systems
15MEC239 Modelling and Simulation of Engineering Systems
15MEC240 Optimization Techniques in Engineering
15MEC241 Pressure Vessel Design
15MEC242 Theory of Elasticity
15MEC243 Tool Design

THERMAL STREAM

15MEC246 Automotive Electronics
15MEC247 Combustion Engineering
15MEC248 Computational Fluid Dynamics
15MEC249 Design of Thermal Systems
15MEC250 Fluid Power Drives and Controls
15MEC251 Fundamentals of Nuclear Engineering
15MEC252 Gas Dynamics and Jet Propulsion
15MEC253 Internal Combustion Engines and Pollution Control
15MEC254 Petroleum Refinery Engineering
15MEC255 Power Plant Engineering
15MEC256 Refrigeration and Air Conditioning
15MEC257 Renewable Sources of Energy
15MEC258 Turbomachinery

MANUFACTURING STREAM

15MEC261 Advanced Casting Technology
15MEC262 Advanced Manufacturing Processes
15MEC263 Advanced Materials and Processes
15MEC264 Advanced Metrology and Sensing Systems
15MEC265 Advanced Welding Technology
15MEC266 CNC Machines
15MEC267 Composite Materials and Processing
15MEC268 Metal Forming Technology
15MEC269 Micro-manufacturing
15MEC270 Modern Practices in Product Design and Manufacture
15MEC271 Non-Destructive Testing
15MEC272 Product Cost Estimation
15MEC273 Quality Control and Reliability Engineering
15MEC274 Simulation, Modelling of Manufacturing Systems

MANAGEMENT

15MEC331 Engineering Economic Analysis
15MEC332 Enterprise Management
15MEC333 Financial Management
15MEC334 Industrial Engineering
15MEC335 Lean Manufacturing
15MEC336 Managerial Statistics
15MEC337 Marketing Management
15MEC338 Operations Management
15MEC339 Project Management
15MEC340 Supply Chain Management
15MEC341 Total Quality Management

SCIENCE ELECTIVES (3 0 0 3)

15CHY231	Advanced Polymer Chemistry
15CHY232	Biomaterials Science
15CHY233	Catalytic Chemistry
15CHY234	Chemistry of Advanced Materials
15CHY235	Chemistry of Engineering Materials
15CHY236	Chemistry of Nanomaterials
15CHY237	Chemistry of Toxicology
15CHY238	Colloidal and Interfacial Chemistry
15CHY239	Computational Chemistry and Molecular Modelling
15CHY241	Electrochemical Energy Systems and Processes
15CHY242	Environmental Chemistry
15CHY243	Fuels and Combustion
15CHY244	Green Chemistry and Technology
15CHY245	Instrumental Methods of Analysis
15CHY246	Medicinal Organic Chemistry
15CHY247	Modern Polymer Composites
15CHY248	Organic Reaction Mechanisms
15CHY249	Organic Synthesis and Stereochemistry
15CHY250	Polymer Materials and Properties
15CHY251	Polymers for Electronics
15CHY252	Solid State Chemistry
15CHY331	Batteries and Fuel Cells
15CHY332	Corrosion Science
15PHY230	Advanced Classical Dynamics
15PHY233	Biophysics and Biomaterials
15PHY234	Introduction to Computational Physics
15PHY238	Electrical Engineering Materials
15PHY239	Electromagnetic Fields and Waves
15PHY240	Electronic Material Sciences
15PHY241	Lasers in Material Processing

15PHY243	Microelectronic Fabrication
15PHY245	Nuclear Energy – Principles and Applications
15PHY247	Photovoltaics
15PHY248	Physics of Lasers and Applications
15PHY250	Quantum Physics and Applications
15PHY251	Thin Film Physics
15PHY331	Astronomy
15PHY333	Concepts of Nanophysics and Nanotechnology
15PHY335	Medical Physics
15PHY338	Physics of Semiconductor Devices
15PHY532	Astrophysics
15PHY535	Earth's Atmosphere
15PHY536	Earth's Structure and Evolution
15PHY540	Nonlinear Dynamics
15PHY542	Optoelectronic Devices1

HUMANITIES ELECTIVES

15CUL230	Achieving Excellence in Life - An Indian Perspective	2 0 0 2
15CUL231	Excellence in Daily Life	2 0 0 2
15CUL232	Exploring Science and Technology in Ancient India	2 0 0 2
15CUL233	Yoga Psychology	2 0 0 2
15ENG230	Business Communication	1 0 2 2
15ENG231	Indian Thought through English	1 0 2 2
15ENG232	Insights into Life through English Literature	1 0 2 2
15ENG233	Technical Communication	1 0 2 2
15ENG234	Indian Short Stories in English	1 0 2 2
15FRE230	Proficiency in French Language (Lower)	1 0 2 2
15FRE231	Proficiency in French Language (Higher)	1 0 2 2
15GER230	German for Beginners I	1 0 2 2
15GER231	German for Beginners II	1 0 2 2
15GER232	Proficiency in German Language (Lower)	1 0 2 2

15GER233	Proficiency in German Language (Higher)	1 0 2 2
15HIN101	Hindi I	1 0 2 2
15HIN111	Hindi II	1 0 2 2
15HUM230	Emotional Intelligence	2 0 0 2
15HUM231	Glimpses into the Indian Mind - the Growth of Modern India	2 0 0 2
15HUM232	Glimpses of Eternal India	2 0 0 2
15HUM233	Glimpses of Indian Economy and Polity	2 0 0 2
15HUM234	Health and Lifestyle	1 0 2 2
15HUM235	Indian Classics for the Twenty-first Century	2 0 0 2
15HUM236	Introduction to India Studies	2 0 0 2
15HUM237	Introduction to Sanskrit Language and Literature	2 0 0 2
15HUM238	National Service Scheme	2 0 0 2
15HUM239	Psychology for Effective Living	2 0 0 2
15HUM240	Psychology for Engineers	2 0 0 2
15HUM241	Science and Society - An Indian Perspective	2 0 0 2
15HUM242	The Message of Bhagwad Gita	2 0 0 2
15HUM243	The Message of the Upanishads	2 0 0 2
15HUM244	Understanding Science of Food and Nutrition	1 0 2 2
15JAP230	Proficiency in Japanese Language (Lower)	1 0 2 2
15JAP231	Proficiency in Japanese Language (Higher)	1 0 2 2
15KAN101	Kannada I	1 0 2 2
15KAN111	Kannada II	1 0 2 2
15MAL101	Malayalam I	1 0 2 2
15MAL111	Malayalam II	1 0 2 2
15SAN101	Sanskrit I	1 0 2 2
15SAN111	Sanskrit II	1 0 2 2
15SWK230	Corporate Social Responsibility	2 0 0 2
15SWK231	Workplace Mental Health	2 0 0 2
15TAM101	Tamil I	1 0 2 2
15TAM111	Tamil II	1 0 2 2

15AES111 INTRODUCTION TO AEROSPACE TECHNOLOGY 3 0 0 3

Unit 1

Visual Content (video) about Atmospheric Dynamics and its Influence on Flying Machines – History of Aviation (visual content) – Types of Flying Machines, Major Components of an Aircraft, and their Functions (visual content) – Aircraft vs Rotorcraft (visual content) – Basic Instruments for Flying (visual content) – Physical Properties and Structure of the Atmosphere: Temperature, Pressure and Altitude Relationships.

Unit 2

Newton's Law of Motions Applied to Aeronautics: Evolution of Lift, Drag and Moment – Aerofoils – General Types of Construction: Monocoque and Semi-monocoque – Typical Wing and Fuselage Structure (visual content) – Basic Ideas about Piston, Turboprop and Jet Engines - Use of Propeller and Jets for Thrust Production (visual content) – Stealth Technology: History and Principles.

Unit 3

History of Space flight (visual content) – Major Components of Rocket, Spacecraft and their Functions (visual content) – Principles of Rocket Engines – The Solar System and the Copernican Model - Kepler's Laws – Orbital Motion – Satellite Orbits - Earth's Outer Atmosphere (visual content).

TEXTBOOK:

Anderson J. D, "Introduction to Flight," 7th edition, McGraw Hill, 2011.

REFERENCES:

1. *Anderson, D. F and Eberhatdt S, "Understanding Flight," 2nd edition, McGraw, 2009.*
2. *Turner M. J, "Rocket and Spacecraft Propulsion," 3rd edition, Springer, 2009.*
3. *Curtis H. D, "Orbital Mechanics for Engineering Students," 3rd edition, Butterworth-Heinemann, 2013.*
4. *Paul A Suhler, "From Rainbow to Gusto: Stealth and the Design of the Lockheed Blackbird," AIAA, 2009.*

15AES201 MECHANICS OF FLUIDS 3 1 0 4

Unit 1

Concept of a Fluid: Continuum, Primary Properties, Compressibility of Fluids, Bulk Modulus, Isothermal & Isentropic Processes, Speed of Sound – Secondary Properties: Viscosity, Newton's Law of Viscosity, Sutherland Equation, Andrade Equation, Surface Tension, Capillarity, Vapor Pressure, Boiling, Cavitation – Hydrostatics: Pascal's Law, Hydrostatic Force on Planar and Non-planar Surfaces, Area Moment of Inertia, Archimedes' Principle, Buoyancy, Stability of Floating Bodies.

Unit 2

Fluid Dynamics: Lagrangian & Eulerian Concepts, Reynolds Transport Theorem, Extensive Property, Intensive Property, Continuity Equation (Differential & Integral Forms) – Conservation of Momentum and Energy: Euler Equation of Motion, Stream Function, Velocity Potential, Bernoulli Equation (Inviscid Steady Flow & Potential Steady Flow) – Laminar Flow: Hagen-Poiseuille Flow, Couette Flow, Plane Poiseuille Flow.

Unit 3

Boundary Layer Development: Boundary Layer Thickness, Displacement Thickness, Momentum Thickness – Momentum Equations: von Karman Momentum Integral Equations (zero pressure gradient), Skin-friction Drag on a Surface – Boundary Layer Equations: Prandtl Boundary Layer Equation and Blasius Solution – Dimensional Analysis: Buckingham Pi-theorem, Method of Repeating Variables – Similitude and Modeling: Modeling Laws, Geometric Similarity, Dynamic Similarity, Kinematic Similarity, Applications.

TEXTBOOK:

Bruce R. Munson, Donald F. Young, Theodore H. Okiishi, "Fundamentals of Fluid Mechanics," 4th edition, John Wiley, 2002.

15AES202 INTRODUCTION TO THERMODYNAMICS 2 1 0 3

Unit 1

Review of the Laws of Thermodynamics – Introduction to Engineering Applications of Thermodynamic Equilibrium – Quasi-static Process – Cyclic Process – Work and Heat – Application of First Law for Open and Closed Systems: Typical Work Transfer and Heat Transfer Devices – Perfect Gas – Equation of State - Specific Heats – Real Gas Models – Compressibility Chart – Thermodynamic Properties of Fluids – Pure Substance – Phase-change Process of Pure Substance – P-V-T Surface – SteamTables.

Unit 2

Introduction to the Application of Second Law of Thermodynamics – Heat Engine – Heat Pump – Refrigerator – Irreversible Processes – Reversible Processes – Carnot Cycle – Carnot Engine – Carnot Theorems – Clausius Inequality – Concept of Entropy and Entropy Change – Introduction to Compressibility and Compressible Flow – Propagation of Sound – Mach number.

Unit 3

Thermodynamic Property Relations: Cyclic Rule, Maxwell Relations, T-D-S Equations – Clausius-Clapeyron Equation – Joule-Thomson coefficient and Inversion Line -

Fundamentals of Power cycles: Air Standard Otto and Diesel Cycles, Rankine Cycle, Reversed Carnot Cycle, Brayton Cycle and its Application in Propulsion Systems.

TEXTBOOKS:

1. *Cengel, Y. A. and Boles, M. A., "Thermodynamics: An Engineering Approach," Tata McGraw, 2002.*
2. *Saad, M. A., "Thermodynamics: Principles and Practice," Prentice Hall, New Jersey, 1998.*

REFERENCE:

Borganakke, S. and Wylen V. "Fundamentals of Thermodynamics," Wiley, New York, 2003.

15AES203 MECHANICS OF MATERIALS 2 1 0 3

Unit 1

Stresses in axial members: Normal stress – St. Venant's principle – normal strain – tension and compression test – stress and strain diagrams – factor of safety – Hooke's law. Axial deformation – principle of superposition – lateral strain – Poisson's ratio – shear stress and strain – shear modulus – volumetric strain – bulk modulus – relation between elastic constants. Stresses in joints – shear and bearing stresses – temperature stress and strain – stress concentration.

Unit 2

Stresses in transverse members: Isolation of beam element – intensity of load, shear force and bending moment relation – shear force and bending moment diagrams – bending stresses in transverse members – Euler – Bernoulli' s simple beam theory – bending stress distribution – shear stresses in transverse members – shear stress distribution.

Unit 3

Deflection in transverse members: Moment-curvature relation – double-integration, Macaulay's – conjugate beam – propped cantilever – fixed beams. Stresses in torsional members: Torsional shear stress – torsion equation for circular section – polar moment of inertia – torsional deformation – stresses due to combined loading.

TEXTBOOK:

James M Gere, Barry J. Goodno "Mechanics of Materials", 8th Edition, Cengage Learning, USA, 2013.

REFERENCES:

1. *Irving H. Shames and James M. Pitarresi, "Introduction to Solid Mechanics" third edition, Prentice-Hall of India Pvt. Ltd. 2006*
2. *Egor P. Popov, "Engineering Mechanics of Solids", Second edition, Prentice-Hall of India Pvt. Ltd., 2004*
3. *S. H. Crandall and N. C. Dahl, "Introduction to Mechanics of Solids", 3rd Edition, Tata McGraw Hill, India, 2013.*

4. *R.C. Hibbeler "Mechanics of Materials", 8th Edition, Pearson Prentice Hall, New Jersey, USA, 2011.*

15AES204 MATERIALS FOR AVIATION AND SPACE 3 0 0 3

Unit 1

Atomic structure, bonding and crystal structure in materials. Imperfections in crystalline solids and their role in influencing materials properties. Mechanical properties: Stress and strain curves for brittle and ductile alloys, elastic, plastic, anelastic, visco-elastic behavior, ductility, resilience, toughness of metals, strengthening mechanisms, grain boundary hardening, solution hardening and work hardening.

Unit 2

Metals and Alloys: Microstructure, properties and applications of ferrous and non-ferrous materials in aviation and space. Solid solutions, solubility limit, phase rule, binary phase diagrams, intermediate phases, intermetallic compounds, recrystallization and grain growth.

Ceramics: Structure, properties and applications of traditional and advanced ceramics for re-entry of space vehicles.

Unit 3

Polymers: Classification of engineering and high performance polymers, additives for engineering and high performance polymers, elastomers. Smart materials and superconductivity, nanomaterials, superalloys. Materials characterization techniques such as, scanning electron microscopy, transmission electron microscopy, atomic force microscopy, differential scanning calorimetry and X-Ray photo electron spectroscopy.

TEXTBOOK:

Cantor B, Assender H, and Grant P (2001), Aerospace Materials, ISBN 07503 0742 0, IOP Publishing Ltd.

REFERENCES:

1. *Gauthier M. M. (1995). Engineered Materials Handbook Materials Park, OH: ASM International. [Comprehensive overview on engineering plastics, elastomers, composites, ceramics and ceramic matrix composites.]*
2. *Boyer R., Welsch G., and Collings E. W. (1994). Materials Properties Handbook: Titanium alloys. Materials Park, OH: ASM International. [Extensive coverage of Ti alloy data.]*
3. *Davis J. R. (1997). ASM Speciality Handbook Heat Resistant Materials. Materials Park, OH: ASM International. [Comprehensive overview on superalloys, ferrous and non-ferrous heat-resistant materials.]*

15AES211 AERODYNAMICS I 3 0 0 3

Unit 1

Importance of Aerodynamics – Classification and Practical Objectives – Aerodynamic Forces – Moments and their Non-dimensionalization – Airfoil Nomenclature – Airfoil Characteristics.

Unit 2

Complex Functions: Analytic Functions and Cauchy-Riemann Criteria, Conformal Mapping, Joukowski Transformation.

Unit 3

Concept of Circulation – Plane Potential Flow – Laplace Equation – Elementary Flows and its Superposition – Kutta Condition – Kutta-Joukowski Theorem – Kelvin's Circulation Theorem – Starting Vortex.

TEXTBOOK:

John D Anderson, "Fundamentals of Aerodynamics,"5th edition, McGraw Hill, 2010.

REFERENCES:

1. *E. L. Houghton and P. W. Carpenter, "Aerodynamics for Engineering Students," 5th edition, Butterworth-Heinemann, 2003.*
2. *Milne-Thomson, "Theoretical Aerodynamics," Dover, 1974.*
3. *Krishnamurthy Karamcheti, "Principles of Ideal-Fluid Aerodynamics,"2nd edition, Krieger Pub Co, 1980.*

15AES212 COMPRESSIBLE FLUID FLOW 2 1 0 3

Unit 1

Review of Thermodynamics: Energy Equation - Compressible Flows: Isentropic Flow, Stagnation Properties. Propagation of Sound, Mach number, Distinction between Subsonic and Supersonic flows, the Acoustic Equation, Finite Waves, Formation of Shock waves.

Unit 2

Flow Through Varying-area Ducts – Normal Shock Wave – Oblique Shock Wave – Shock Polar – Shock Wave Interactions – Prandtl-Meyer Expansion – Effect of Back Pressure on Nozzle Flows – Supersonic Wind Tunnels.

Unit 3

Fanno Flow – Rayleigh Flow – Representation of Shock Waves on the T-S Diagram – Small Perturbation Theory – Similarity Rules – Introduction to the Method of Characteristics.

TEXTBOOK:

John D Anderson, "Modern Compressible Flow," 3rd edition, McGraw Hill, 2002.

REFERENCES:

1. *Shapiro A. H, "The Dynamics and Thermodynamics of Compressible Fluid Flow," Vol.1, Ronald Press Company, 1977.*
2. *Zucker R. D and Biblarz. O, "Fundamentals of Gas Dynamics," 2nd edition, John Wiley, 2002.*

15AES213 AEROSPACE STRUCTURES I 3 0 0 3

Unit 1

Stress at a point, stress transformations, principal stresses, normal and shear strains, strain transformations, principal strains, Mohr's circle, bi-axial and tri-axial stresses, generalized Hooke's law, plane stress and plane strain, analysis of thin and thick walled pressure vessels.

Unit 2

Types of riveted, bolted, and welded joints, merits and demerits of various joints, study of failure behavior and simple design of joints, strain and potential energies, strain energy density, gradually applied loads and suddenly applied loads, Castigliano's theorem I and Castigliano's theorem II, Maxwell-Betti's theorem, unit load method and its applications, principle of virtual work, principle of virtual displacement and principle of virtual force.

Unit 3

Buckling of columns, Euler's formula, effective length, load versus deflection plot, load eccentricity, imperfections, South-well plot, beam columns, maximum principle stress theory, maximum principle strain theory, maximum strain energy theory, maximum shear stress (Tresca) theory, and maximum distortion (von-Mises) theory, loads on an aircraft, characteristics of aircraft structures, basic structural members in aircraft structures and their functions.

TEXTBOOKS:

1. *James M Gere, Barry J. Goodno "Mechanics of Materials", 8th Edition, Cengage Learning, USA, 2013.*
2. *R. C. Hibbeler "Mechanics of Materials", 8th Edition, P P Hall, New Jersey, USA, 2011.*

REFERENCES:

1. *James M Gere, Stephen P. Timoshenko "Mechanics of Materials", 2nd Edition, CBS Publishers, New Delhi, 1986.*
2. *Srivastava, Gope " Strength of Materials", Prentice-Hall of India, 2007*
3. *C.T. Sun, "Mechanics of Aircraft Structures", Second Edition, John Wiley & Sons, New York, 2006.*
4. *Megson, T. H. G., "Aircraft Structures for Engineering Students", Butterworth-Heinemann, USA, 2007.*

15AES214 INTRODUCTION TO CONTROL THEORY 2 1 0 3

Unit 1

Mathematical Modeling: Linear Systems, Block Diagrams, Feedback, Input Test Signals, Laplace Transforms. Transfer Functions, State Space Representation.

Unit 2

Definition of Stability – Response vs Pole Locations – Time Domain Specifications – System Type and Steady-State Errors – Routh's Stability Criterion – Root Locus – Guidelines for Sketching – Bode Plot Techniques – Nyquist Criterion – Stability Margins (Gain and Phase).

Unit 3

Root Locus Design Method: Dynamic Compensation (Lead/Lag), PID Controllers – Frequency Response Design Method – Robust Stability and Robust Performance – Introduction to State Space Design, Controllability and Observability – Introduction to State - Feedback and Estimator Design.

TEXTBOOKS:

1. R. C. Dorfand R. H. Bishop, "Modern Control Systems," 9th edition, Prentice-Hall, 2001.

2. Norman S. Nise, "Control Systems Engineering," 6th edition, Wiley India, 2012.

REFERENCE:

Ogata, K. "Modern Control Engineering," 5th edition, Prentice Hall, 2010.

15AES281 MEASUREMENT AND INSTRUMENTATION LAB. 0 0 2 1

Calibration exercises on general purpose test (GPT) equipment such as Oscilloscope, signal generator, and pressure gauges.

Measurement experiments: Displacement using LVDT, velocity using Pitot tube and anemometer, force using Proving ring and load cell, torque using strain gauges, speed using stroboscope and magnetic pickup, and temperature using thermocouple.

Mini Projects: Interdisciplinary in content based on application of course work completed by the student.

15AES285 MECHANICS OF FLUIDS LAB. 0 0 2 1

Flow Experiments: Calibration of Orificemeter and Venturimeter, V and Rectangular Notches, Pipe Friction, Verification of Bernoulli's Theorem, Reynold's Apparatus, Metacentric Height, Jet Impact Studies.

15AES286 MATERIALS TESTING LAB. 0 0 2 1

Tension test on metals, hardness test on metals using the Rockwell and Brinell tests, impact tests on metals using the Charpy and Izod equipments, double shear tests, helical spring tests, static bending and compression tests on wood and deflection test to verify the Maxwell reciprocal theorem.

In addition to the conventional tests, students are assigned to open lab projects that involve experimental studies including fabrication and setting up unconventional testing methods to understand the basic concepts of strength of materials.

15AES301 AERODYNAMICS II 2 1 0 3

Unit 1

Classical Thin Airfoil Theory for Symmetric and Cambered Airfoils: Lift and Moment Coefficients, Center of Pressure, Predicting Zero Lift Angle of Attack, Flapped Airfoils, Effects of Thickness.

Unit 2

Finite Wing Theory: The Concept of Downwash and Induced Drag – Classical Theorems: Curved Vortex Filament, Biot-Savart Law, Helmholtz's Vortex Theorems – Method of Analysis: Prandtl's Classical Lifting Line Theory, Modern Numerical Lifting Line Method, Lifting Surface Theory, Modern Vortex Lattice Numerical Method.

Unit 3

Flow Physics Associated with Delta Wings: Subsonic Flow Pattern, Pressure Envelope, Leading Edge Vortex Flap (LEVF) Technology and Performance Comparison, Buffeting Phenomena and Types of Vortex Breakdown.

TEXTBOOK:

John D Anderson, "Fundamentals of Aerodynamics," 5th edition, McGraw Hill, 2010.

REFERENCE:

E. L. Houghton and P. W. Carpenter, "Aerodynamics for Engineering Students," 5th edition, Butterworth-Heinemann, 2003.

15AES302 AEROSPACE PROPULSION 2 1 0 3

Unit 1

Momentum Analysis of Thrust Generation – Types of Propulsion Systems and their Components – Performance Measures – Propellers: Performance Coefficients – Review of Thermodynamic Cycles - Ideal Cycle Analysis: Ramjets, Turbojets and Turbofan Engines.

Unit 2

Component Performance – Analysis of Real Engines – Chemistry of Combustion – Heat of Combustion – Reaction Rate – Flames – Stability Considerations – Application to Gas Turbine Combustion – Fuels: Properties, Conventional and Modern Aviation Fuels.

Unit 3

Rocket Vehicle Mechanics – Multistaging – Thermodynamics of Rocket Engine – Rocket Engine Performance – Types of Rocket Engines – Fuels for Solid and Liquid Propellant Rockets – Rocket Cooling.

TEXTBOOK:

Mattingly.Jack. D, "Elements of Propulsion: Gas Turbines and Rockets," AIAA Education Series, 2006.

REFERENCES:

1. *Turner Martin, "Rocket and Spacecraft Propulsion," 3rd edition, Springer, 2009.*
2. *Mukunda. H. S, "Understanding Combustion," 2nd edition, Macmillan India Limited, 2007.*

15AES303 AEROSPACE STRUCTURES II 3 0 0 3

Unit 1

Introduction to theory of elasticity: equilibrium equations, boundary conditions, constitutive relations, plane stress and plane strain conditions, stress and displacement formulations, strain compatibility relation, governing equations, inverse and semi-inverse methods, Airy's stress function, Torsion in non-circular bars, Prandtl stress function, St. Venant warping function, membrane analogy, torsion in narrow rectangular section.

Unit 2

Euler–Bernoulli and Timoshenko beam theories, bi-directional bending, bending and transverse shear stresses, bending stresses in narrow rectangular section, general symmetric sections, and thin-walled sections, flexural shear flows (FSF), FSF in thin-walled open sections, shear center in open sections.

Unit 3

Torsional shear flows (TSF) in thin-walled open sections, TSF in thin-walled closed sections (single and multiple cells) and warping in open and closed thin-walled sections, FSF in thin-walled closed sections (single and multi-cells) and shear center in closed sections, buckling of non-symmetrical sections and buckling of thin-walled sections.

TEXTBOOK:

C. T. Sun, "Mechanics of Aircraft structures", John Wiley & sons, New York, 2006.

REFERENCES:

1. *Megson, T. H. G., "Aircraft Structures for Engineering Students", Butterworth-Heinemann, USA, 2007*
2. *Peery, D. J., and Azar, J. J., "Aircraft Structures", 2nd edition, McGraw–Hill, New York, 1993.*
3. *Bruhn. E. H. "Analysis and Design of Flight vehicles Structures", Tri – state off set company, USA, 1985.*
4. *Rivello, R. M., "Theory and analysis of flight structures" McGraw-Hill, New York, 1969.*

15AES304 AVIONICS 3 0 0 3

Unit 1

Introduction: Importance and Role of Avionics, the Avionic Environment – Air Data Systems: Air Data Information and its Use, Air Data Laws and Relationships, Air Data Sensors and Computations.

Unit 2

Embedded Systems: Basic Hardware Building Blocks of a Typical Embedded System – Software Concepts Relevant to Avionics: Interrupts and Real Time Operating Systems – Case Studies Illustrating Importance of Embedded Systems in Avionics – Introduction to Electronic Communication Systems – Utility of Radio Navigation Aids.

Unit 3

Inertial Sensors and Systems: Laser and MEMS Gyros, Accelerometers, Attitude Heading Reference System – Navigation Systems: Basic Principles, Inertial Navigation, Strapped-Down Inertial Systems – Introduction to Autopilot and UAV Avionics.

TEXTBOOK:

R. P. G Collinson, "Introduction to Avionics", Springer, 2002.

REFERENCES:

1. *Kaytonand Fried, "Avionics Navigation Systems", Wiley, 1997.*
2. *Frank Vahid, Tony Givargis, "Embedded System Design", Wiley, 2006.*

15AES311 FINITE ELEMENT METHODS FOR AEROSPACE 2 1 0 3

Unit 1

Introduction to FEM - equilibrium condition, strain-displacement relation, linear constitutive relations - domain discretization, types of elements, assembly procedures, boundary conditions - Formulations: Potential energy method, Variational formulation, Weighted residual, Galerkin and Rayleigh-Ritz methods.

Unit 2

Coordinate systems, convergence criteria, 1D Elements: Axial elements basic formulations, formations of shape functions, problems using 1D elements, Beam (bending) element: formulations and formation of shape function and problems – 2D elements: Plane stress and Plane strain element formulation, shape function development, problems using 2D elements - axi-symmetric elements - iso-parametric formulation of elements.

Unit 3

3D element formulations - Introduction to FE formulation of Plate bending and shell elements - Numerical integration - Solution techniques of the numerical equations - Introduction to FE software - FE modeling of aircraft and spacecraft components - Application of boundary conditions and loadings on FE models - Analysis of subcomponents like wings, fuselage, motor casing, etc.

TEXTBOOK:

Daryl L. Logan, "A First Course in the Finite Element Method", CL, New Delhi, 2007.

REFERENCES:

1. *C. S. Krishnamoorthy, "Finite Element Analysis", Tata McGraw-Hill Publishing Company Limited, New Delhi, 1999.*
2. *David V. Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw-Hill Publishing Company Limited, New Delhi.*
3. *Megson, T. H. G., "An introduction to aircraft structural analysis", Butterworth-Heinemann, USA, 2010.*
4. *Tirupathi R. Chandrapatla and Ashok D. Belegundu, "Introduction to Finite Element in Engineering", Prentice Hall of India, New Delhi.*

15AES312 FLIGHT MECHANICS 2 1 0 3

Unit 1

Equations of Motion – Forces Acting on the Aircraft – Review of Aerodynamic characteristics of the Wing and Compressibility Effects – Review of Propulsion Systems and their Performance Characteristics – Drag Contribution from Aircraft Components – Airplane Performance of Turbojets: Steady Flight, Range, Endurance, Conditions for Maximum Range and Endurance, Climb Performance, Turn Performance, Maximum Load Factor During Turn.

Unit 2

Glide Performance - Take-Off and Landing Performance – Performance of Piston-Props: Steady Flight Climb and Turn Performance, Climb Performance, Turn Performance, Comparison with Turbojets - Turbofan and Turboprop Performance Evaluation Guidelines.

Unit 3

Concept of Static and Dynamic Stability – Longitudinal Stability: Neutral Point, Stick-Fixed and Stick-Free Stability – Longitudinal Control – Hinge Moments – Control Power – Directional Stability and Control – Lateral Stability and Control – Introduction to Dynamic Stability – Stability Derivatives.

TEXTBOOKS:

1. *Hale, Francis J, "Introduction to Aircraft Performance, Selection, and Design". Wiley, 1984.*
2. *Nelson. R. C, "Flight Stability and Automatic Control", 2nd edition, McGraw-Hill, 1998.*

REFERENCES:

1. *Perkins. C. D and Hage. R. E, "Aircraft Performance, Stability and Control", 11th edition, Wiley, 1967.*
2. *Anderson. J. D, "Aircraft Performance and Design", McGraw-Hill, 2010.*
3. *Russel. J. B, "Performance and stability of aircraft", Butterworth-Heinemann, 1996.*

15AES332 FUNDAMENTALS OF HEAT TRANSFER 3 0 0 3

Unit 1

Basic Modes of Heat Transfer: Steady State Calculations with Multiple Modes of Heat Transfer – One-Dimensional Steady State Heat Conduction: Composite Medium, Critical Thickness, Effect of Variation of Thermal Conductivity in Solids, Extended Surfaces – Unsteady State Heat Conduction: Lumped System Analysis – Heat Transfer in Semi-infinite and Infinite Solids - Application of Numerical Techniques.

Unit 2

Fundamentals of Convection: Physical Mechanism, Reynolds Analogy - Free Convection In Vertical Flat Plate – Empirical Relation in Free Convection – Forced Convection – Laminar and Turbulent Convective Heat Transfer Analysis in Flows between Parallel Plates, over Flat Plate and in Circular Pipe – Applications of Numerical Techniques in Problem Solving.

Unit 3

Boiling and Condensation – Radiative Heat Transfer: Introduction to Physical Mechanism, Radiation Properties, Radiation Shape Factors, Heat Exchange between Non-Black Bodies, Radiation Shields. Classification of Heat Exchangers – Temperature Distribution – Overall Heat Transfer Coefficient – Heat Transfer in Gas Turbine Combustion Chambers, Rocket Thrust Chambers and Cryogenic Systems.

TEXTBOOK:

Incropera. F. P. and Dewitt. D. P., "Fundamentals of Heat and Mass Transfer," 5th edition, John Wiley and Sons, New York, 2002.

REFERENCES:

1. *Yunus A. Cengel., "Heat Transfer – A practical approach," 2nd edition, Tata McGraw-Hill, 2002*
2. *Holman. J. P., "Heat Transfer," 6th edition, McGraw-Hill, New York, 1991.*
3. *Sutton. G. P., "Rocket Propulsion Elements," 5thedition, John Wiley and Sons, New York, 1986.*

15AES342 EXPERIMENTAL AERODYNAMICS 3 0 0 3

Unit 1

Examples of Fluid Mechanics Measurements: Wind-Tunnel Studies, Turbulent Mixing Layer, Spatial and Temporal Resolution in Measurements, Classification of Deterministic Data, Random Data, Signal Analysis and Uncertainty Analysis.

Unit 2

Qualitative Characterization: Flow Visualization in Liquid and Gaseous Medium, Colored Filament, Smoke, Vapor and Tufts Visualization, Image Processing Techniques, Identifying Structures - Optical Systems for Flow Measurement: Shadowgraph, Schlieren and Interferometric Techniques.

Unit 3

Quantitative Characterization: Drag Measurements, Static Probes, Pressure Sensitive Paints (PSP), Velocity Measurements, Pitot-Static Probe, Theromocouple, Thermal Anemometers (Hot Wire and Film Sensors), Laser Velocimetry (LDA), Particle Image Velocimetry (PIV).

TEXTBOOK:

Cameron Tropea, Alexander L Yarin, John F Foss, "Springer Handbook of Experimental Fluid Mechanics," Springer, 2007.

REFERENCES:

1. *Richard J Goldstein, "Fluid Mechanics Measurements," 2nd edition, Taylor & Francis, 1996.*
2. *Wolfgang Merzkirch, "Flow Visualization," Academic Press, 1974.*

15AES352 VIBRATION ANALYSIS 3 0 0 3

Unit 1

Introduction to vibration, undamped vibration, natural frequency, damped vibration, viscous damped system, under, over and critically damped system, logarithmic decrement, Coulomb damping, response to initial condition, response to simple harmonic motion, rotating unbalance, base excitation, whirling of shafts, vibration measuring instruments, response to periodic motion.

Unit 2

Response to non-periodic motions, impulse response, step response, convolution and Du Hamel integrals, Numerical methods: Runge-Kutta method, Normal mode

analysis, response to initial conditions, beat phenomenon, response to simple harmonic motion, damped vibration, static and dynamic coupling, principle coordinate, decoupling, Rayleigh's proportionality damping, vibration absorber.

Unit 3

Modeling of multi-degree freedom system, stiffness and flexibility influence coefficients, modeling of beam and portal members, response to periodic and non-periodic motions, modal analysis (mode – synthesis method), Vibration of continuous: Free vibration of string, bar, shaft and beam.

TEXTBOOK:

W. T. Thomson, "Theory of vibrations with applications," Pearson, 1997.

REFERENCES:

1. *Leonard Meirovitch, "Elements of vibration Analysis," Tata McGraw Hill, 1986.*
2. *Leonard Meirovitch, "Fundamentals of vibration," McGraw Hill, 2001.*
3. *S. S. Rao, "Mechanical vibrations," Pearson, 2010.*

15AES353 COMPOSITE MATERIALS AND MECHANICS 3 0 0 3

Unit 1

Introduction to Composites: Concept of Composite materials, Classification of Composites, Various types of composites, Classification-based on Matrix Material: Organic Matrix Composites (Polymer matrix composites (PMC) / Carbon Matrix Composites or Carbon-Carbon Composites, Advantages of Composites materials. Reinforcements and Matrices for various types of composites Fibers / Reinforcement Materials, Role and Selection of reinforcement materials, Types of fibers, Mechanical properties of fibers,

Unit 2

Functions of Matrix, Desired Properties of Thermosets and Thermoplastics, Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc. Laminated composites, Lamina and Laminate Lay-up, Ply-orientation definition, Manufacturing processes. Testing of Composites:Mechanical testing of composites, Tensile testing, Compressive testing.

Unit 3

Determination of longitudinal and transverse strengths of lamina, mechanics of short fiber composites, stress-strain relationships of anisotropic lamina with arbitrary orientations, analysis of laminated composites, types of laminates, stress-strain variation in laminates using classical lamination theory, thermal stresses in laminates, different types of failure criteria, introduction to inter-laminar stresses in composites.

TEXTBOOK:

Jones R. M., "Mechanics of Composite Materials", Hemisphere Publishing Corporation, New York

REFERENCES:

1. *Agarwal B. D. and Broutmen L. J. "Analysis and performance of Fiber Composites", John Wiley and Sons, New York 1990.*
2. *Chawla, Krishan K (2012), Composite Materials, Science and Engineering, ISBN: 978-0-387-74365, Springer.*
3. *Sam Zhang, Dongliang Zhao (2013), Aerospace Materials Handbook, ISBN: 978-1-4398-7329-8, Taylor and Francis.*
4. *Leonard Hollaway (1994), Handbook of Polymer Composite for Engineers, ISBN: 1-85573-1290, Woodhead Publishing Ltd.*

15AES372 MANUFACTURING PROCESSES 3 0 0 3

Unit 1

Introduction to casting, rolling, forging, extrusion, drawing and sheet metal working-types of defects and remedies.

Unit 2

Introduction to welding and their types, Welding defects: causes and remedies. Rivet and it types. Definition and concept – production of metal powders - characteristics of metal powders - compaction - sintering – design consideration - process capability - applications.

Unit 3

Abrasive jet machining, ultrasonic machining, Electro-discharge machining, electrochemical machining and laser beam machining. Surface modification processes - diffusion coating – electroplating – anodizing - conversion coating - hot dipping - ceramic and diamond coating.

Rapid Prototyping & Its types, CNC and Types of CNC's.

TEXTBOOK:

F. C. Campbell, "Manufacturing Technology for Aerospace Structural materials", Elsevier Science Ltd; 1 edition (15 August 2006)

REFERENCES:

1. *Serope Kalpakjian and Steven R. Schmid, 'Manufacturing Engineering and Technology', Pearson Education Asia, 2000 (fourth ed.) (Indian Reprint 2000).*
2. *P. K. Mishra, 'Nonconventional Machining process', Narosa Publishing House, 2006.*
3. *A. Azad, 'Fundamentals of Computer Aided Manufacturing', Jaico Publishing House, 2006.*

15AES373 ADVANCED AVIONICS 3 0 0 3

(Prerequisite - 15AES304AVIONICS or equivalent)

Unit 1

Electromagnetic Wave Propagation and its Relevance to Aviation – Electronic Communication Systems: Functional Description of Basic Building Blocks, Antenna, Amplifier, Filter, Modulator and Demodulator – Introduction to Digital Communication and Telemetry.

Unit 2

System Level Description of Radio Navigation Aids: Instrument Landing System, Very High Frequency Omni Range, Automatic Direction Finder, Distance Measuring Equipment, GPS, Radar, Traffic Alert and Collision Avoidance.

Unit 3

Autopilots and Flight Management System: Autopilots, Flight Management Systems – Avionic System Integration: Background, Data Bus Systems, Integrated Modular Avionics.

TEXTBOOKS:

1. *R. P. G Collinson, "Introduction to Avionics", Springer, 2002.*
2. *Frenzel Louis, "Principles of Electronic Communication Systems", 4th Edition, McGraw-Hill, 2015.*

REFERENCES:

1. *Kaytonand Fried, "Avionics Navigation Systems", 2nd edition, Wiley, 1997.*
2. *Dale R. Cundy, Rick S. Brown, "Introduction to Avionics", Prentice Hall, 1997.*

15AES381 AERO-STRUCTURES LAB. 0 0 2 1

Determination of principal axis in unsymmetrical bending of beams, experiment on constant strength beam, determination of shear centre location for open and closed sections, testing of beam with combined loading, measurement of vibrations of beams, Wagner beam – Tension field beam experiments, determination of stresses in thin wall cylinder and finding the buckling strength of column using the South well plot test.

In addition to the conventional tests, students are assigned to open lab projects that involve experimental studies including fabrication and setting up unconventional testing methods to understand the basic concepts of thin walled member behavior.

15AES382 AVIONICS LAB. 0 0 2 1

Control System Exercises using MATLAB / Kits: Open Loop and Closed Loop Responses for Position, Velocity and Température Control Systems.

Mini Projects: Related to Avionics

15AES383 PROPULSION LAB. 0 0 2 1

Euler's Turbomachine Equation – Classification of Turbomachines – Velocity Triangles for Turbines and Compressors – Axial Flow Machines.

Propeller Testing: Estimation of Static Performance, Estimation of Figure of Merit – Nozzle Testing: Mach number Distribution along a Convergent-divergent Nozzle – Flame Speed Measurement: Variation of Flame Speed with Equivalence Ratio – Study of Free Incompressible Jet: Study of Velocity Profiles and the Entrainment Process – Cascade Testing: Measurements of Velocity and Pressure in a Cascade Flow Field: Effect of the Variation in Angle of Attack.

TEXTBOOK:

Phillip Hill and Carl Peterson, "Mechanics and Thermodynamics of Propulsion," 2nd edition, Dorling Kindersely (India), 2010.

15AES384 LOW-SPEED AERODYNAMICS LAB. 0 0 2 1

Wind Tunnel Calibration: Velocity Measurements, Boundary Layer Thickness Characterization - Quantification of Level of Turbulence in the Wind Tunnel: Sphere Test – Pressure or Form Drag Measurements: Finite and Infinite Wings, Fuselage, UAV, Locomotives – Flow Visualization: Smoke, Tuft, Surface Coating – Image Processing: Essential Aspects of Image Enhancement Utilizing Commercial Software MATLAB to extract Flow Structures – Open Projects relevant to Aerodynamics.

15AES385 INNOVATIONS LAB. 0 0 2 1

Identification of Problem – Identification of Criteria and Constraints – Market Study – Brainstorming for Possible Solutions – Generation of Ideas – Exchange of Ideas and Obtaining Feedback from Mentors and Batch-mates – Exploration of Possibilities – Study of Environmental and Social Impact of Innovative Ideas – Convergence on Methodology and Solution to the Problem – Viability for Scaling Up – Build a Model or Prototype – Paper Submissions / Patent Proposals.

15AES390 / 15AES490 LIVE-IN-LAB. 3 cr

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or rural sites during the vacations (after fourth semester or sixth semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth or seventh semester. The objectives and projected outcome of the project should be reviewed and approved by the Dept. chairperson and a faculty assigned as the project guide. On completion of the project, the student shall submit a detailed project report. The report shall be evaluated and the students shall appear for a viva-voce test on the project.

15AES401 COMPUTATIONAL FLUID DYNAMICS FOR AEROSPACE 2 1 0 3

Unit 1

Introduction to Numerical Methods – Properties of Numerical Solutions: Errors, Consistency, Accuracy, Stability, Convergence, Conservation – Review of Governing Equations of Fluid Dynamics – Review of Classification of PDE's and their Physical Implications for Compressible Flows.

Unit 2

Introduction to the Finite Difference Methods: Discretization of Temporal and Spatial Derivatives,Explicit and Implicit Formulations – Mccormack's Scheme, Extensions to Viscous Flows – Shock Capturing – Lax-Wendroff Method.

Unit 3

Stability Analysis: Von Neumann Stability Criteria, CFL Criterion for Stability – Introduction to Grid Generation: Body Conforming Grids, Algebraic and Elliptic Grids, 2D Unstructured Grids, C-Grids, O-Grids and H-Grids for Flow Past Airfoils and Wings – Simulation of External and Internal Flows as Applied to Aerospace Components.

TEXTBOOK:

John D Anderson, "Computational Fluid Dynamics – The Basics with Application", McGraw Hill, 1995.

REFERENCES:

1. *Tuncer Cebeci, Max Platzer, Hsun Chen, Kuo-Cheng Chang, Jian P. Shao, "Analysis of Low Speed Unsteady Airfoil Flows," Springer, 2005.*
2. *Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu, "Computational Fluid Dynamics – A Practical Approach," Elsevier, 2008.*

15AES402 AERO-DESIGN 2 2 2 5

Unit 1

Review of Aircrafts and Spacecrafts – Introduction to Design Process: Design Requirements, Data Collection & Statistical Study, Conceptual, Preliminary and Detailed Designs, Regulatory Requirements.

Unit 2

Weight, Volume and Size Estimates: Fixed Wing, Flapping Wing and Rotary Wing Vehicles, Launch Vehicles, Satellites, Lunar and Interplanetary Vehicles, Atmospheric Re-Entry Vehicles, Missiles, Airships, Aerostats and Parachutes – Aerodynamic and Control Surface Design for Atmospheric Vehicles and Space Vehicles – Selection and Design of Propulsion System.

Unit 3

Weight Distribution and Stability Estimates – Estimation of Control Characteristics – Performance Evaluation and Trade-Off Studies – Current Technological and Regulatory Trend Studies – Market Study.

TEXTBOOK:

Daniel P. Raymer, "Aircraft Design - A Conceptual Approach," 5th edition, AIAA Education Series, 2012.

REFERENCES:

1. *Ajoy Kumar Kundu, "Aircraft Design," Cambridge University Press, 1st Edition, 2010.*
2. *Leeland M Nicolai and Grant E. Carichner, "Fundamentals of Aircraft and Airship Design - Volume I," AIAA, 1st Edition, 2010.*
3. *Leeland M Nicolai and Grant E. Carichner, "Fundamentals of Aircraft and Airship Design - Airship Design & Case Studies - Volume II," AIAA, 1st Edition, 2013.*
4. *Anderson. J. D, "Aircraft Performance and Design", McGraw-Hill, 2010.*

15AES403 FLIGHT DYNAMICS AND CONTROL 3 0 0 3

Unit 1

Review of Static Stability – Concepts and Introduction to Dynamic Stability – Review: Body Axis, Stability Axis, Earth Axis – Euler Angles – Transformation between Axis – Advantages of Axis – Aircraft Equations of Motion – Kinematic Equations.

Unit 2

Small Perturbation Theory: Linear Equations of Motion, Stability Derivatives, Longitudinal and Lateral Modes – Concept and Physics – Characteristic Equation – Transfer Function Approach – State Space Modeling and Application to Modes.

Unit 3

Flying and Handling Qualities – Autopilots – Stability - Augmentation System (Longitudinal and Lateral Control) – Fly-By-Wire Aircraft – Active Control System – Control Configured Vehicles – Introduction to Relaxed Static Stability – Gust Load Alleviation – Smart Airplanes – Introduction to Digital Control and Stability.

TEXTBOOK:

M. V. Cook, Flight Dynamics Principles, "A Linear Systems Approach to Aircraft Stability and Control," 3rd Edition, Elsevier, 2013.

REFERENCES:

1. *Robert C Nelson, "Introduction to Flight Stability and Automatic Control," 2nd Edition, Mcgraw-Hill, 1998.*
2. *Warren F Philips, "Mechanics of Flight", Wiley, 2004.*

15AES430 ROCKET AND SPACECRAFT PROPULSION 3 0 0 3

(Prerequisite AES212 COMPRESSED FLUID FLOW or equivalent)

Unit 1

Principle of Rocket Propulsion – Rocket Equation – Development of Thrust – Nozzle Design – Effect of Atmosphere – Thermodynamic Thrust Equation – Characteristic Velocity – Performance Parameters.

Unit 2

Liquid Propellant Rocket Engine – Cryogenic and Semi-cryogenic Engines – Basic Configuration – Types of Propellants – Propellant Feed Systems – Combustion of Liquid Propellants – Injectors and Thrust Chambers – Combustion Instability – Solid Propellant Fundamentals –Types of Solid Propellants – Propellant Processing and Manufacture – Grain Configuration – Igniter Hardware – Combustion of Solid Propellants – Hybrid Rocket Engines.

Unit 3

Electric Propulsion: Electrothermal and Electromagnetic Thrusters, Applications of Electric Propulsion, Electric Power Generation – Nuclear Propulsion – Operational Issues – Practical Approaches for Single Stage to Orbit Vehicles.

TEXTBOOKS:

1. *Truner. Martin, "Rocket and Spacecraft Propulsion," 3rd edition, Springer, 2009.*
2. *Sutton. G. P, Biblarz. O, "Elements of rocket propulsion," 7th edition, John Wiley & Sons Inc, 2010.*

15AES432 AIR BREATHING ENGINES 3 0 0 3

Unit 1

Review of Cycle Analysis of Air-Breathing Engines – Application of Euler's Turbo Machinery Equation to Axial and Centrifugal Machines: Velocity Diagrams, Stage Parameters, Three Dimensional Flows in Turbo-Machinery – Components of Axial and Centrifugal Turbines – Performance Maps – Compressor Turbine Matching – Surge Control.

Unit 2

Thermal Limits of Blades and Vanes – Blade Cooling, Film Cooling and Regenerative Cooling – Subsonic, Supersonic and Hypersonic Inlets – Inlet Sizing – Inlet Performance – The Combustion Process: Stability, Length Scaling.

Unit 3

Fuels – Types of Combustors – Combustor Performance – Afterburners – Flame Stabilization – Nozzles, Thrust Vectoring – Nozzle Performance.

TEXTBOOK:

Mattingly. Jack. D, "Elements of Propulsion: Gas Turbines and Rockets," AIAA Education Series, 2006.

REFERENCES:

1. *Flack. R. L, "Fundamentals of Jet Propulsion with Applications," Cambridge University Press, 2005.*
2. *Hill and Peterson, "Mechanics and Thermodynamics of Propulsion," Dorling Kindersely (India), 2010.*

15AES440 TURBULENT FLOWS 3 0 0 3

Unit 1

Onset of Turbulence: Laminar Flow, Transition, Turbulent Flow – Laminar - Turbulent Transition: Taylor's Rotating Cylinder Experiment, Benard's Natural Convection Experiment, Reynolds Experiment, Reynolds Number Concept Based on Volume Flux and Pressure Gradient – Stability Theory of Laminar Flows: Method of Small Disturbances, Orr-Sommerfeld Equation, Modes of Stability, Curve of Neutral Stability, Indifference Reynolds Number, Absolute and Convective Instabilities.

Unit 2

Inviscid Instability: Rayleigh Equation, Point of Inflection Criteria, Critical Layer – Fundamentals of Turbulent Flow: Mean Motion, Fluctuations, Quasi-steady Approach, Apparent Viscosity, Reynolds Stresses (Momentum Theorem & Navier-Stokes Equations), Classical Empirical Results on Turbulence, Wind-tunnel Turbulence.

Unit 3

Semi-empirical Hypothesis: Eddy Viscosity, Prandtl Mixing Length – Isotropic Turbulence: Kolmogorov Hypothesis, Kolmogorov Length and Time Scales - Free Turbulent Flows: Jet Boundary, Free Jet, Wake.

TEXTBOOK:

Herrmann Schlichting, Klaus Gersten, "Boundary Layer Theory," 8thedition, Springer-Verlag, 2000.

REFERENCES:

1. *Pijush K. Kundu, Ira M. Cohen, David R. Dowling, "Fluid Mechanics," 5th edition, Academic Press, 2012.*
2. *Davidson, P. A., "Turbulence: An Introduction for Scientists and Engineers," Oxford University Press, 2004.*

15AES441 ADVANCED COMPUTATIONAL FLUID DYNAMICS 3 0 0 3

Unit 1

Strong and Weak Form of Conservation of Equations – Introduction to Finite Volume Method: Discretization Schemes and their Properties for Finite Volume Method.

Unit 2

Finite Volume Method for Convection - Diffusion Problems: Central Differencing, Upwind Differencing, Power-Law Differencing, Quick and TVD Schemes with their Assessments – Staggered and Collocated Grids – Introduction to Multigrids – Flux-Vector Splitting.

Unit 3

Introduction to Solution Algorithms: SIMPLE, SIMPLER, SIMPLEC and PISO Algorithms – Introduction to Turbulence Models and Associated Parameters – Introduction to Aerodynamic Shape Optimization – Introduction to Spectral Methods.

TEXTBOOKS:

1. *Hirsch, "Numerical Computation of Internal and External Flows- Vol1-2", 2nd edition, Elsevier, 2007.*
2. *Veertseeg. H, Malalasekara. W, "An Introduction to Computational Fluid Dynamics - The Finite Volume Approach", 2nd ed., Pearson Education Ltd., 2008.*

REFERENCES:

1. *T.J. Chung, "Computational Fluid Dynamics,"2nd edition, Cambridge University Press, 2010.*
2. *John Tannehill, Dale Anderson, Richard Pletcher, "Computational Fluid Mechanics and Heat Transfer," 3rd Edition, CRC Press, 2013.*
3. *Canuto C., Hussaini M. Y., Quarteroni A., and Zang T. A., "Spectral Methods. Fundamentals in Single Domains." Springer-Verlag, 2006.*

15AES442 HYPERSONIC FLOW THEORY 3 0 0 3

Unit 1

Introduction – Basic Considerations and Definitions – Videos of Atmospheric Re-Entry – Thin Shock Layer – Entropy Layer – Viscous Interaction – Low Density Flows – High Temperature Effects – Visual Presentation of Damages due to High Temperature Effects – Hypersonic Flight Paths.

Unit 2

Inviscid Hypersonic Flow Theory: Shock Expansion Method, Surface Inclination Methods – Small Disturbance Equations and Approximate Methods – Similarity Laws.

Unit 3

Exact Methods – Method of Characteristics Review – Unit Processes for Method of Characteristics: Planar, Axisymmetric and 3-D Flows – Blunt Body Problem and Shock Interaction Types – Modern Computational Methods – Introduction to Viscous Hypersonic Flows.

TEXTBOOK:

John D. Anderson, "Hypersonic and High Temperature Gas Dynamics," McGraw Hill, 2002.

REFERENCE:

Wallace D. Hayes and Ronald F. Probstein, "Hypersonic Flow Theory," 2nd edition, Academic Press, 1959.

15AES450 SURFACE ENGINEERING, COATING AND JOINING TECHNOLOGIES 3 0 0 3

Unit 1

Introduction: Engineering components, surface dependent properties and failures, importance and scope of surface engineering. Surface and surface energy: Structure and types of interfaces, surface energy and related equations. Surface modification of steel and ferrous components, Surface modification using gaseous medium: Nitriding carbonitriding (diffusion from gaseous state) (principle and scope of application).

Unit 2

Surface engineering by energy beams: General classification, scope and principles, types and intensity / energy deposition profile. Surface engineering by energy beams: Laser assisted microstructure modification – surface melting, hardening, shocking and similar processes. Surface engineering by spray techniques: Plasma coating (principle and scope of application). Characterization of surface microstructure and properties.

Unit 3

Fundamentals of Adhesive Bonding, Stress Distribution in Adhesive Bonding, Adhesive Bonding geometry and fracture analysis, Adhesive bonding of similar and dissimilar materials, Fundamentals of welding, Stress Distribution in welding.

TEXTBOOK:

Peter M. Martin (2011), Introduction to Surface Engineering and Functionally Engineered Materials, ISBN 978-0-470-63927-6, Scrivener Publishing LLC.

REFERENCES:

1. *Arthur A. Tracton (2006), Coatings Technology Handbook, ISBN 978-1-57444-649-4, Taylor & Francis Group LLC.*
2. *Samuel Benavides (2009), Corrosion Control in the Aerospace Industry, ISBN 13: 9781845693459, Woodhead Publishing Ltd.*

15AES452 ENGINEERING FRACTURE MECHANICS 3 0 0 3

Unit 1

Introduction to fracture mechanics (FM), historical development of FM-Linear and elasto-plastic fracture mechanics introduction, modes of loading, crack growth on fracture mechanics, brittle failure and ductile failure concept study. Study on energy release rate, review of theory of elasticity, Airy's stress theory on 2D models. Double cantilever beam energy release rate (ERR) definition, Energy release rate derivation on different geometries, ERR based on displacement of crack faces mechanisms, Necessary and sufficient condition of FM and stable and unstable FM.

Unit 2

Stress field analysis – different approaches to predict stresses, displacement formulation, compatibility conditions, principal of superposition. Crack-tip stress and displacement field - Cauchy-Riemann conditions, Westergaard's stress function, stress intensity factors derivations. Crack opening displacement (CTOD/COD), very near-tip displacement field (Mode - I, II, III), multi-parameter stress field, K for different load conditions. Crack opening displacement (CTOD/COD).

Unit 3

Energy release rate by J-integral approach, relation study between K and G. Study of surface cracks, stress intensity factor study on finite body Evaluation of SIF by experimental and numerical approaches and also using strain gauges. Fracture toughness tests – plane strain test, Compact tension test, three-point bending test, C-specimen test, Chevron notch test.

TEXTBOOK:

Anderson, T. L., "Fracture Mechanics", 2nd Edition, CRC Press, 1995.

REFERENCES:

1. *Ramesh, K., "e-book on Engineering Fracture Mechanics", IIT-Madras publisher.*
2. *Prashant Kumar, "Elements of Fracture Mechanics" Tata McGraw-Hill Education, 2009.*

15AES453 AERO-ELASTICITY 3 0 0 3

Unit 1

Free vibration analysis of basic structural members with different boundary conditions, analytical and approximate solutions, response of basic structural members to periodic and non-periodic forces, mode synthesis, approximate solutions.

Unit 2

Static aero-elasticity, divergence of a typical airfoil section, aileron reversal, divergence of one dimensional structures: straight and swept wings, aileron reversal of one dimensional straight wing.

Unit 3

Aeroelastic flutter, stability characteristics, aeroelastic analysis of a typical airfoil section: single degree and two degree freedom, classical flutter analysis, classical unsteady aerodynamic theory, engineering solution for flutter, U-g and p-k methods, response to gust loads.

TEXTBOOK:

Dewey H. Hodges, and G. Alvin Pierce, "Introduction to structural dynamics and aeroelasticity," Cambridge University Press, 2002

REFERENCES:

1. *Raymond L. Bisplingoff, Holt Ashley, Robert L. Haffman.,"Aeroelasticity", Dover Publications,1996.*
2. *Raymond L. Bisplingoff, Holt Ashley, "Principles of Aeroelasticity", Dover Publications, 2002.*

15AES454 ADVANCED COMPOSITE STRUCTURES 3 0 0 3

Unit 1

Concept of aviation and space environments. Ionizing and non ionizing radiation at Low Earth Orbit (LEO) and Geo Synchronous Earth Orbit (GEO). Charged plasma and atomic oxygen in space. Different thermosetting and thermoplastic polymers and their applications as structural and semi structural components for aviation and spacecraft.

Unit 2

Durability of thermosetting and thermoplastic polymers under aviation and space environments. Scope of high performance polymers. Scope of high performance and ultra high performance polymers. Defects of composites under mechanical fatigue, thermal fatigue, humidity, lightening strike, ultra violet radiation, ultra high vacuum and high energy radiations.

Unit 3

Simulation of test facilities in laboratory. State of the art technologies to repair composite defects. Importance of nano composite and nano adhesive bonding. Importance of fire resistant polymeric composites and electrically conductive composites.

TEXTBOOK:

Omari V. Mukbaniani, Marc J. M. Abadie, Tamara Tatrishvili (2015), High-Performance Polymers for Engineering-Based Composites, ISBN 9781771881197 - CAT# N11265, CRC Press.

REFERENCES:

1. *Yu Bai, Thomas Keller (2014), High Temperature Performance of Polymer Composites, ISBN: 978-3-527-32793-5, Wiley-VCH.*
2. *Eric Baer (1991), High Performance Polymers: Structures, Properties, Composites, Fibers, ISBN-13: 978-1569900024, Amazon Prime*

15AES460 SPACE FLIGHT MECHANICS 3 0 0 3

Unit 1

Elements of Conics – The n-Body Problem and Reduction to Two-Body Problem – Types of Orbits – Conservation of Energy and Angular Momentum in Orbits – Spherical Trigonometry – Geocentric-Equatorial, Heliocentric-Ecliptic, Right Ascension Declination, Topocentric-Horizon and Perifocal Co-Ordinate Systems and Transformations Between Them – Classical Orbital Elements.

Unit 2

Orbital Elements Determination from Position and Velocity at a Point – Determining Position and Velocity from Orbital Elements – Orbit Determinations from a Single Radar Observation, Three Position Vectors and Optical Sightings – Ellipsoidal Earth Model: Geodetic and Geocentric Latitudes – Ground Trace of Satellites – Solar and Sidereal Times – Precession of The Equinoxes – Low and High Earth Orbits: Orbital Perturbations due to Oblateness of Earth – Orbital Maneuvers: General Coplanar Orbit Transfer, Hohmann Transfer, Simple Plane Changes to an Orbit.

Unit 3

Time-of Flight and Eccentric Anomalies for Elliptic, Parabolic And Hyperbolic Orbits – Kepler's Problem and Solution Algorithm – Gauss Problem: General Methods of

Solution – Intercept and Rendezvous with Examples – Ballistic Missile Trajectories: Effect of Earth Rotation – Interplanetary Trajectories: Spheres of Influence and the Patched Conic Approximation, Synodic Periods – Satellite Attitude Dynamics: Torque Free Motion, Stability of Torque Free Motion, Spin Stabilization, Gyroscopic Attitude Control, Gravity Gradient Attitude Control.

TEXTBOOKS:

1. *Roger R Bate, Donald D Mueller, Jerry E White and William W Saylor, "Fundamentals of Astrodynamics," 2nd edition, Dover, 2015.*
2. *Marshall H Kaplan, "Modern Spacecraft Dynamics and Control," Wiley, 1976.*

REFERENCES:

1. *Howard Curtis, "Orbital Mechanics for Engineers and Scientists," 3rd edition, Elsevier, 2010.*
2. *Marcel J. Sidi, "Spacecraft Dynamics and Control: A Practical Engineering Approach," Cambridge University Press, 1997.*

15AES461 PRINCIPLES OF AIRPORT MANAGEMENT 3 0 0 3

Unit 1 Introduction

History of Aviation - Development of Air transportation in India - Major players in Airline Industry - Swot analysis in Airline Industry - Market potential of Indian Airline Industry - Current challenges in Airline Industry - Completion in Airline Industry - IATA & ICAO.

Airport management:

Airport planning - Operational area and Terminal planning, design, and operation - Airport operations - Airport functions - Organization structure of Airline and Airports sectors - Airport authorities - Global and Indian scenario of Airport management – DGCA – AAI.

Unit 2 Air transport services:

International trends - Emerging Indian scenario – PPP - Public Private Participation in Indian Airports - Environmental regulations - Private participation in International developments - Environment regulations - Regulatory issues - Meteorological services for Aviation - Airport fees, rates, and charges.

Airline operations:

Airline Terminal Management - Flight Information Counter / Reservation and Ticketing - Check In/Issue of Boarding pass - Customs and Immigration formalities - Co-ordination - Security Clearance - Baggage and Handling of Unaccompanied minors and Disabled Passengers - Handling of Stretcher Passengers and Human Remains - Handling of CIP, VIP & VVIP - Co-ordination of Supporting Agencies / Departments.

Unit 3

Logistics and air cargo management:

Concept of Logistics - Role of Ware Housing - trend in material handling - Global Supply Chain - Quality concept and Total Quality Management - improving Logistic performance - Air Cargo Concept - Cargo Handling - Booking of Perishable Cargo and Live Animals - Industry Relation - Type of Air Cargo - Air Cargo Tariff, ratios and Charges - Airway Bill, Function, Purpose.

TEXTBOOKS:

1. *Wells. A, "Airport Planning and Management," 4th edition, McGraw-hill, London, 2000.*
2. *Alexander T. Well, Seth Young, "Principles of Airport Management," McGraw Hill 2003*

15AES462 HELICOPTER THEORY 3 0 0 3

Unit 1

Historical development, configurations of helicopters, rotor system, flight control and mechanism, hovering theory, momentum theory for hover and vertical flight, blade element theory for hover and vertical flight, combined blade element momentum (BEM) theory.

Unit 2

Momentum theory for forward flight, various non-uniform inflow models, blade element theory for forward flight, non-dimensional hub forces and moments, estimation of power for forward flight.

Unit 3

Idealization of rotor blades, flap-lag and torsional dynamics of the blade, rotor blade flapping motion: A simple model, helicopter trim analysis.

TEXTBOOK:

C. Venkatesan, "Fundamentals of helicopter dynamics," CRC Press, 2015

REFERENCES:

1. *W. Johnson, "Helicopter theory", Princeton University, 1980.*
2. *R. S. Bramwell, "Helicopter dynamics", Edward Arnold Publications, 1976*

15AES470 STATE SPACE TECHNIQUES 3 0 0 3

Unit 1

Concepts of Matrix Algebra and Vector Spaces (revision) – Solution of Simultaneous Equation for Squares – Under-Determined and Over-Determined Systems – Concepts of Basis Vector Transformations; Similarity and Adjoint Transformation – Eigen Values and Eigen Vectors:Canonical Forms, Jordon Forms, Characteristic Equations, Analytical Functions of Square Matrices, Cayley-Hamilton Theorem.

Unit 2

Concepts of State, State-Space and State-Vector – Mathematical Modes in the State Space Form – State Equation and High-Order Differential Equations – State Space Form for Aerospace Systems, for e.g., Dynamic Behavior of Aircraft, Missile, Satellites, INS., etc. – Solution of Homogenous State Equations.

Unit 3

Solution of Non-Homogenous State Equations – Controllability and Observability of Systems – Concepts of Output Feedback and Full State Feedback, Pole-Placement Design – Concept of an Observer – Basics of Optimal Control.

TEXTBOOKS:

1. *Friedland, B. "Control System Design", Dover, 2005.*
2. *Nise, Norman S. "Control Systems Engineering," 4th Edition, Wiley, 2004.*

15AES471 MULTIDISCIPLINARY DESIGN OPTIMIZATION 3 0 0 3

Unit 1

Single Variable Optimization: Introduction to Optimization, Optimality Criteria – Bracketing Methods: Exhaustive Search Method, Bounding Phase Method, Region Elimination Methods, Golden Section Search Method, Gradient Based Methods: Newton-Raphson Method, Bisection Method, Secant Method, Cubic Search Method.

Unit 2

Multivariable Optimization: Optimality Criteria – Gradient Based Methods: Steepest Descent Method, Conjugate Direction Method, Conjugate Gradient Method and Newton's Method – Constrained Optimization: Karush-Kuhn-Tucker Optimality Criteria, Direct Methods, Indirect Methods, Penalty Function Methods.

Unit 3

Global Optimization: Simulated Annealing, Genetic Algorithm, Particle Swarm Optimization, Multi-Objective Optimization – Pareto Optimality –Global Function / Weighted Sum.

TEXTBOOK:

Kalyanmoy Deb, "Optimization for Engineering Design Algorithms and Examples", 2nd edition, Prentice Hall of India, New Delhi, 2012.

REFERENCES:

1. *Kalyanmoy Deb, "Multi-Objective Optimization using Evolutionary Algorithms", Wiley, 2010.*
2. *J. Arora, "Introduction to Optimum Design," 3rd Edition, Elsevier, 2012.*

15AES481 UAV LAB. 0 0 2 1

Flight testing using a 3.5 Kg UAV or simulator, to determine following:
Glide performance;
Climb rate;
Range and endurance;
Turn rate;
Short period and Phugoid mode;
Roll subsidence.

15AES495 PROJECT PHASE I 2 cr

Various project titles based on areas covered up to 7th semester are allotted to batches of 3 to 4 students.

Preliminary studies and investigations on the allotted topic.

15AES499 PROJECT PHASE II 10 cr

To achieve objectives and to carry out detailed investigation towards the outcome of each allotted project.

15AVP201 / AMRITA VALUES PROGRAMME I / 1 0 0 1
15AVP211 AMRITA VALUES PROGRAMME II 1 0 0 1

Amrita University's Amrita Values Programme (AVP) is a new initiative to give exposure to students about richness and beauty of Indian way of life. India is a country where history, culture, art, aesthetics, cuisine and nature exhibit more diversity than nearly anywhere else in the world.

Amrita Values Programmes emphasize on making students familiar with the rich tapestry of Indian life, culture, arts, science and heritage which has historically drawn people from all over the world.

Students shall have to register for any two of the following courses, one each in the third and the fourth semesters, which may be offered by the respective school during the concerned semester.

Courses offered under the framework of Amrita Values Programmes I and II

Message from Amma's Life for the Modern World

Amma's messages can be put to action in our life through pragmatism and attuning

of our thought process in a positive and creative manner. Every single word Amma speaks and the guidance received in on matters which we consider as trivial are rich in content and touches the very inner being of our personality. Life gets enriched by Amma's guidance and She teaches us the art of exemplary life skills where we become witness to all the happenings around us still keeping the balance of the mind.

Lessons from the Ramayana

Introduction to Ramayana, the first Epic in the world – Influence of Ramayana on Indian values and culture – Storyline of Ramayana – Study of leading characters in Ramayana – Influence of Ramayana outside India – Relevance of Ramayana for modern times.

Lessons from the Mahabharata

Introduction to Mahabharata, the largest Epic in the world – Influence of Mahabharata on Indian values and culture – Storyline of Mahabharata – Study of leading characters in Mahabharata – Kurukshetra War and its significance - Relevance of Mahabharata for modern times.

Lessons from the Upanishads

Introduction to the Upanishads: Sruti versus Smrti - Overview of the four Vedas and the ten Principal Upanishads - The central problems of the Upanishads – The Upanishads and Indian Culture – Relevance of Upanishads for modern times – A few Upanishad Personalities: Nachiketas, SatyakamaJabala, Aruni, Shvetaketu.

Message of the Bhagavad Gita

Introduction to Bhagavad Gita – Brief storyline of Mahabharata - Context of Kurukshetra War – The anguish of Arjuna – Counsel by Sri. Krishna – Key teachings of the Bhagavad Gita – Karma Yoga, Jnana Yoga and Bhakti Yoga - Theory of Karma and Reincarnation – Concept of Dharma – Concept of Avatar - Relevance of Mahabharata for modern times.

Life and Message of Swami Vivekananda

Brief Sketch of Swami Vivekananda's Life – Meeting with Guru – Disciplining of Narendra - Travel across India - Inspiring Life incidents – Address at the Parliament of Religions – Travel in United States and Europe – Return and reception India – Message from Swamiji's life.

Life and Teachings of Spiritual Masters India

Sri Rama, Sri Krishna, Sri Buddha, Adi Shankaracharya, Sri Ramakrishna Paramahamsa, Swami Vivekananda, Sri Ramana Maharshi, Mata Amritanandamayi Devi.

Insights into Indian Arts and Literature

The aim of this course is to present the rich literature and culture of Ancient India and help students appreciate their deep influence on Indian Life - Vedic culture, primary source of Indian Culture – Brief introduction and appreciation of a few of the art forms of India - Arts, Music, Dance, Theatre.

Yoga and Meditation

The objective of the course is to provide practical training in YOGA ASANAS with a sound theoretical base and theory classes on selected verses of Patanjali's Yoga Sutra and Ashtanga Yoga. The coverage also includes the effect of yoga on integrated personality development.

Kerala Mural Art and Painting

Mural painting is an offshoot of the devotional tradition of Kerala. A mural is any piece of artwork painted or applied directly on a wall, ceiling or other large permanent surface. In the contemporary scenario Mural painting is not restricted to the permanent structures and are being done even on canvas. Kerala mural paintings are the frescos depicting mythology and legends, which are drawn on the walls of temples and churches in South India, principally in Kerala. Ancient temples, churches and places in Kerala, South India, display an abounding tradition of mural paintings mostly dating back between the 9th to 12th centuries when this form of art enjoyed Royal patronage. Learning Mural painting through the theory and practice workshop is the objective of this course.

Course on Organic Farming and Sustainability

Organic farming is emerging as an important segment of human sustainability and healthy life. Haritamritam' is an attempt to empower the youth with basic skills in tradition of organic farming and to revive the culture of growing vegetables that one consumes, without using chemicals and pesticides. Growth of Agriculture through such positive initiatives will go a long way in nation development. In Amma's words "it is a big step in restoring the lost harmony of nature".

Benefits of Indian Medicinal Systems

Indian medicinal systems are one of the most ancient in the world. Even today society continues to derive enormous benefits from the wealth of knowledge in Ayurveda of which is recognised as a viable and sustainable medicinal tradition. This course will expose students to the fundamental principles and philosophy of Ayurveda and other Indian medicinal traditions.

Traditional Fine Arts of India

India is home to one of the most diverse Art forms world over. The underlying philosophy of Indian life is 'Únity in Diversity" and it has led to the most diverse

expressions of culture in India. Most art forms of India are an expression of devotion by the devotee towards the Lord and its influence in Indian life is very pervasive. This course will introduce students to the deeper philosophical basis of Indian Art forms and attempt to provide a practical demonstration of the continuing relevance of the Art.

Science of Worship in India

Indian mode of worship is unique among the world civilisations. Nowhere in the world has the philosophical idea of reverence and worshipfulness for everything in this universe found universal acceptance as it in India. Indian religious life even today is a practical demonstration of the potential for realisation of this profound truth. To see the all-pervading consciousness in everything, including animate and inanimate, and constituting society to realise this truth can be seen as the epitome of civilizational excellence. This course will discuss the principles and rationale behind different modes of worship prevalent in India.

15CHE111 INTRODUCTION TO CHEMICAL ENGINEERING 3 0 0 3

Unit 1

Historical evolution of chemical engineering; what is chemical Engineering; the impact & role of chemical engineering; representing chemical processes using process diagrams and flow sheets (introduction to unit operations and unit processes; batch vs. continuous operation); understanding prevalent symbols; chemical process industries: evolution, broad classification, characteristics, origin, growth, present scenario, & projections; opportunities and challenges; roles of the modern chemical engineer.

Physical quantities: units & dimensions, conversion & conversion factors; important process variables, making the connection between the variables and their measurements; conventions in methods of analysis and measurement, basis, chemical equations and stoichiometry, conversion, and yield; industrially important physical and chemical properties.

Unit 2

Introduction to fluid flow (pressure-flow interaction, non-flowing fluids, pumps & turbines), heat transfer (applications of heat exchange in the industry), mass transfer (molecular vs. bulk transport), reaction engineering (important of describing reaction rate and design of reaction vessel), materials (important properties and their influence on selection of materials), and control (need for control and strategies); mathematical representation of process; types of chemical engineering problems (mainly rate, equilibrium and design).

Unit 3

Computer aided calculations & spreadsheets; graphing (basic plots, interpreting trends, curve fitting, log-log & semi-log representation); relation between chemical engineering and physico – chemical sciences and other engineering disciplines; modern view of chemical engineering; economics (costs in industry, profitability considerations, analytical view of process and reporting of performance); safety-health-environment; ethics; case studies.

TEXTBOOKS & REFERENCES:

1. *K. A. Solen and J. N. Harb, "Introduction to Chemical Engineering – Tools for Today and Tomorrow", 5th Edition, Wiley, 2011.*
2. *S. Pushpavanam, "Introduction to Chemical Engineering", Prentice Hall India, 2012.*

15CHE112 MATERIAL BALANCES 3 1 0 4

Unit 1

Chemical engineer vs. Chemist, Careers in chemical engineering, Chemical engineering industries; Chemical engineering approach – Streams, Units and Processes; Unit operations and processes: Fluid and solid operations, Heat transfer operations, Mass transfer and separation operations, Chemical reactors, Control of processes, Costing and economics, Process flowsheets and components; Case studies.

Representing streams: Dimensions and unit conversions, Conversion factors, Dimensional consistency, Dimensionless numbers in chemical engineering; Representing compositions of mixtures and solutions: Binary and tertiary mixtures, Graphical representation, Compound stoichiometry; Representing gas phases: Ideal gas law, P-V-T calculations, Partial pressures and pure component volumes in mixtures; Representing reactions: Reaction stoichiometry, Conversion, Yield, Selectivity, Limiting and excess reactants; Dissociating gases; Representing moist gases: Humidity, Wet and dry bulb temperatures, Humidity chart.

Unit 2

Material balance – Control volume, Conservation of mass and species in a unit; Steady and unsteady state processes, Batch and continuous processes; Basis for calculation; Degrees of freedom; Steady and unsteady material balance in unit operations: Evaporation; Crystallization; Leaching; Adsorption; Drying; Liquid-Liquid Extraction; Absorption; Distillation; Recycle, Bypass, and Purge

Unit 3

Combustion: Orsat analysis, Proximate and ultimate analyses of coal; Single-pass and overall conversions; Oxidation of sulphur compounds; Reactions involving phosphorus; Reactions involving nitrogen; Reactions involving chlorine; Extraction

of metals from ores; Hydrogenation, hydration, and oxidation; Electrochemical reactions; Recycle, Bypass, and Purge involving reactions

Representing processes: Creating Flowsheets; Degree of freedom analysis of flowsheets; Material balance involving multiple unit operations; Modular and overall equation-solving approaches; Case studies involving industrial flowsheets.

TEXTBOOKS:

1. *Bhatt, B. L., and Vora, S. M., Stoichiometry, 3rd Edition, Tata McGraw Hill, New Delhi, 1996*
2. *Narayanan, K. V., and Lakshmikutty, B., Stoichiometry and Process Calculations, Prentice Hall India, New Delhi, 2009*
3. *Murphy, R. M., Introduction to Chemical Processes: Principles, Analysis, Synthesis, McGraw Hill International Edition, New York, 2007*

REFERENCES:

1. *Himmelblau, D. M., Basic Principles and Calculations in Chemical Engineering, 6th Edition, Prentice Hall Inc., New York, 2003*
2. *Felder, R. M. and Rousseau, R. R., Elementary Principles of Chemical Processes, 3rd Edition, John Wiley & Sons, New York, 2000*
3. *Hougen, O. A., Watson, K. M., and Ragatz, R.A., Chemical Process PrinciplesPart I, CBS Publishers, 1973*
4. *Lewis, W. K., Radash, A. H., and Lewis, H. C., Industrial Stoichiometry, McGraw Hill Book Inc., New York, 1995*

15CHE201 ENERGY BALANCE AND THERMODYNAMICS 3 0 2 4

Unit 1

Systems, Properties, Processes, Cycles; State of a system and state postulate; State and path functions; Temperature and zeroth law of thermodynamics; Pressure and pressure measurement; Energy and its forms: Potential and Kinetic energy, Internal energy; Energy sources; Energy transfer – Heat, Work, Electricity; Mechanisms of heat transfer; Work: Moving boundary work, Flow work, Shaft, spring, elasticity, surface tension, and electrical work; Energy balance – First law for open and closed systems, steady and unsteady state processes.

Phases and phase diagrams of a pure substance, Saturation, Superheating, T-v, P-v, P-T diagrams and the P-v-T surface; Enthalpy; Property tables; Ideal and non-ideal gases: van der Waals, Soave-Redlich-Kwong, Peng-Robinson equations of state; Virial equation and its physical meaning; Compressibility factor.

Unit 2

Estimation of heat capacities: Solids, Liquids, Gases, Mixtures, Temperature dependence; Enthalpy changes: Mixing, Fusion, Vaporization – Clayperon equation,

Clausius-Clayperon equation, Watson equation, Trouton's rule, Kistyakowsky equation; Energy analysis of gas cycles; Energy analysis using property tables.

Mechanical energy balance – Bernoulli equation; Energy transfer by mechanical work: Nozzles and diffusers, Turbines, compressors and pumps, Throttling valves, Pipe and duct flow; Energy transfer by heat: Heat exchangers, Boilers and Furnaces; Energy balance in unit operations: Mixers and splitters; Drying; Evaporation; Crystallization; Leaching; Adsorption; Liquid-Liquid Extraction; Absorption; Distillation; Recycle, Bypass, Purge.

Unit 3

Standard heat of reactions – Combustion and Formation; Hess's law; Effect of temperature and pressure; Adiabatic reaction temperature; Recycle in reactors; Combined material and energy balance in flowsheets – Degree of freedom analysis; Modular and overall equation-solving approaches.

Entropy and thermodynamic temperature; Combined first and second law for closed systems and cycles: Carnot cycle; Refrigerators, Heat pumps; Thermodynamic efficiency and coefficient of performance; Second law for open systems – Entropy balance; Statistical meaning of entropy.

TEXTBOOKS:

1. *Narayanan, K. V., and Lakshmikutty, B., Stoichiometry and Process Calculations, Prentice Hall India, New Delhi, 2009*
2. *Cengel, Y. A., and Boles, M. A., Thermodynamics: An Engineering Approach, 7th Special Indian Edition, McGraw Hill India, New Delhi, 2011*
3. *Rao, Y. V. C., Chemical Engineering Thermodynamics, Universities Press, 1997*

REFERENCES:

1. *Murphy, R. M., Introduction to Chemical Processes: Principles, Analysis, Synthesis, McGraw Hill International Edition, New York, 2007*
2. *O'Connell, J. P., and Haile, J. M., Thermodynamics: Fundamentals for Applications, Cambridge University Press, Cambridge, 2005*

15CHE202 FLUID MECHANICS 3 1 0 4

Unit 1

Elementary concepts – density, specific weight, specific gravity, viscosity – dynamic and kinematic viscosity – surface tension, capillarity, vapour pressure, compressibility – Compressible and incompressible fluids; Concept of gauge and absolute pressure, measurement of pressure using manometers of different types. Hydrostatic force on plane and curved surfaces, center of pressure; buoyancy and stability of submerged and floating bodies;

Flow types - Unsteady, Steady and non-uniform, laminar and turbulent flows – Reynolds number; Ideal flow – rotational and irrotational, stream function, potential function – Velocity vectors; Path line, streak line and stream line; Derivation of continuity and momentum equation for steady three dimensional flows - Application of one dimensional steady flow; circulation and vorticity; Laminar flow between parallel plates – Taylor-Coutte flow and Poiseulle flow; Flow in closed conduits Laminar flow through circular pipe – Shear stress and velocity profiles; pressure gradient, Hagen-Poiseulle's equation; Power required to overcome pressure drop; Velocity profile in turbulent flows;

Two dimensional flows - Boundary layer; Boundary layer equation; Blasisus solution for boundary layer flow; boundary layer separation and its control.

Unit 2

Bernoulli's and Euler's equations; Application of Bernoulli's equations to flow meters - Pitot tube, Nozzle, Venturi meter and Orifice meter; Coefficient of discharge for flow meters and velocity measurement;

Concept of friction and friction factor from drag on a flat plate; Friction loss in laminar and turbulent flows, Darcy-Weisbach equation, Moody chart; Minor losses – Pipe fittings and pipe networks, equivalent length for pipe in pipe fittings;

Flow past immersed bodies – drag and lift, drag and lift coefficients, flow though beds of solids, one dimensional motion of particle through fluid, terminal velocity, hindered settling, Fluidization – Conditions for onset of fluidization, Hydraulic radius of porous medium, Porous medium Reynolds number, minimum fluidization velocity; Pressure drop through porous media for spherical and non-spherical particles – Ergun equation; Types of fluidization;

Unit 3

Applications Transportation of fluids – pipes, fittings, valves; Pump terminology – Suction and Delivery heads, Suction lift, Cavitation, Net positive suction head and Power requirement; Positive displacement pumps – Reciprocating pump and gear pump; Rotary pumps - Centrifugal Volute pump, Pressure raise in centrifugal pump; Pump characteristics;

Significance of dimensionless numbers; Dimensional analysis and model testing – Bucking ham pi-theorem; Application of dimensionless analysis - Flow through pipe, Settling of particles in a fluid, Centrifugal pump, Reynolds and Froude numbers and their use in model testing;

TEXTBOOK AND REFERENCE BOOKS:

1. *Noel de Nevers, Fluid Mechanics for Chemical Engineers, McGraw Hill Inc., 1991*
2. *Cengel Y. A., and Cimbala J. H, Fluid Mechanics: Fundamentals and Applications, McGraw Hill Publishers, 3rd Ed., 2013*
3. *Holland F. A., and Bragg R., Fluid Flow for Chemical Engineers, Butterworth Heinmann, 2nd Ed., 2002*
4. *Ron Darby, Chemical Engineering Fluid Mechanics, Marcel Dekker Inc., 2nd Ed., 2001*
5. *Frank M. White, Fluid Mechanics, MeGraw Hill Inc., 4th Ed., 2011*

15CHE203 MECHANICAL OPERATIONS 3 0 0 3

Unit 1

Properties and handling of particulate solids- characteristics of solid particles, standard screen series, mixed particle size and screen analysis; Screening: Theory of screening, Effectiveness and Capacity of screens, Screening equipment: stationary screens and grizzlies, gyrating screens, vibrating screens and other industrial screens like trammels, etc. Transportation and storage of solids: bins, hoppers and silos, flow out of bins; conveyor selection, different types of conveyers and their performance characteristics.

Comminution of solids (Size Reduction): Factors affecting comminution, comminution laws: Kick's law, Rittinger's law and Bond's law and their limitations. Crushing efficiency & power consumption, Size reduction equipments: Primary crusher – Jaw crusher, Gyratory crusher, Secondary crusher – Roll crusher (both smooth roll & toothed roll) its selection and capacity, Grinder – Construction and operation of Hammermill, Ball mill, Rod mill, Attrition mill, Agitated mill and their materials suitability, Ultra-fine grinder – Fluid energy mill, Cutting machines: knife cutters, Close circuit and Open circuit operation.

Unit 2

Separation of solids: gravity settling, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier.Centrifugal separation - continuous centrifuges, bowl classifier, super centrifuges, design of basket centrifuges; Industrial dust removing equipment - cyclones and hydro cyclones, with special reference to electrostatic and magnetic separators; Heavy media separations, floatation.

Mixing and Agitation: Mixing of liquids (with or without solids), mixing of liquids (with solids), mixing of liquids (with solids), mixing of powders, selection of suitable mixers, power requirement for mixing.

Unit 3

Filtration: Principle of Cake filtration, Pressure drop through filter media, compressible and incompressible filter cakes, Constant pressure and rate filtration, Continuous filtration, washing of filter cakes; Filtration – Theory, Filtration considerations, Batch and continuous filtration equipment (Pressure and Vacuum) – selection, operation and design of filters and optimum cycle of operation.

TEXTBOOKS:

1. *W. L. McCabe, J. C. Smith, and P. Harriot, "Unit Operations in Chemical Engineering, 6th Edition, McGraw Hill, 2001.*
2. *W. L. Badger and J. T. Banchero, "Introduction to Chemical Engineering", Tata McGraw Hill, 1997.*
3. *A. S. Foust, L. A. Wenzel, C. W. Clump, L. Naus, and L. B. Anderson, "Principles of Unit Operations", 2nd Edition, John Wiley & Sons, 1994.*

REFERENCE:

J. M. Coulson and J. F. Richardson,"Chemical Engineering Vol.I", 4th Edition, Asian Books Pvt Ltd., India, 1998.

15CHE211 CHEMICAL ENGINEERING THERMODYNAMICS 3 0 0 3

Unit 1

Pure gaseous substances – P-v-T behavior of pure substances, Calculation of work done, heat transferred, change in enthalpy in different processes – Ideal and Non-ideal gases; Equation of State, Compressibility factor.

Gas Mixtures – P-v-T behavior of gas mixtures, ideal and non-ideal mixtures, Mixture rules, Compressibility factors for mixtures.

Excess properties of mixtures – Temperature and Pressure dependence, Gibbs-Duhem equation;

Unit 2

Ideal and non-ideal solutions; vapor pressure of solutions; fugacity and activity coefficients and their estimation; Criterion for vapor liquid equilibrium (VLE); Binary VLE – Bubble and dew point calculations – Equation of State and Activity Co-efficient models; Multi-component VLE – K-factor approach; Thermodynamic consistency of VLE data.

Criterion for liquid-liquid equilibrium; Estimation of distribution co-efficient from activity models; Composition estimation in problems related to extraction.

Unit 3

Criterion for chemical reaction equilibrium – feasibility of chemical processes, Equilibrium constant;

Conversion calculations in a reaction – Homogeneous gas phase reactions, Gas-Liquid reactions, effect of temperature and pressure on conversion.

TEXTBOOK AND REFERENCE BOOKS:

1. *Y. V. C. Rao, Chemical Engineering Thermodynamics, 1st Ed., 2001*
2. *J. P. O'Connell and J. M. Haile, Thermodynamics: Fundamentals for Applications, Cambridge University Press, 2005*
3. *Yunus A. Cengel, Thermodynamics: An Engineering Approach, 7th Ed., 2010*

15CHE212 CHEMICAL TECHNOLOGY 4 0 0 4

Unit 1

Chemical processing, the role of a chemical engineers in process industries, importance of block diagrams and flow charts, unit operations, unit processes, process utilities and economics, industrial safety and pollution, outline of plant and equipment design, process control and instrumentation; Chlor-Alkali: Definition of electrochemistry, manufacture of soda ash by solvay process, manufacture of chlorine & caustic soda by diaphragm cell, advantages & disadvantages of diaphragm & comparison with mercury cell. Cement: Definition of cement &portland cement, process description, raw material, flow sheet & major engineering problems associated with the dry processes for manufacturing of portland cement; Glass & Ceramics: Definition and general composition of glass, raw material, methods of manufacture, special glasses - fused silica and high silica glass; Ceramics – properties, classification, manufacturing process; Types of refractories and manufacturing processes; kilns. Inorganic Acids: Flow sheet, raw materials, industrial applications, and engineering problems for Sulfuric acid (includes production of Sulfur) and Hydrochloric acid. Soap & Detergent industry: Continuous hydrolysis & saponification process, flow sheet for continuous process, for fatty acids, soap & glycerine; types of surface active agents, different constituents of detergent, manufacturing process of detergent (sulfonation and sulfation and compounding of detergent). Vegetable Oils: Extraction methods, hydrogenation of vegetable oils, general methods of production; Pulp & Paper Industry: Kraft process for pulp manufacture, Fourdrinier and Cylinder Machine processes for paper manufacture, and paper finishing;

Unit 2

Fertilizer Industry: mixed and direct-application fertilizers, NPK value, granulation, Haber process for Ammonia synthesis; Petroleum Refining Industry: Constituents of petroleum, products of refining, processing or refining; Petrochemicals Industry: Unit operations, chemical conversions, manufacture of petrochemicals, reactions producing petrochemicals; Paints & Varnishes: Brief description of requirements for surface coatings, simple flow sheet of paint coatings, simple flow sheets of paint manufacturing process, varnishes & their applications; Dyes and Intermediates: Raw materials, important cyclic intermediates, chemical conversions, structure and classification of dyes.

Unit 3

Polymers & Plastics Industries: Definitions, types of polymers, classifications, polymerization reactions, manufacture of PE,PP, PVC; Phenolic and epoxy resin. Rubber Industries: Natural and synthetic rubber, rubber compounding, rubber fabrication, latex compounds, and rubber derivatives; Pharmaceutical: Classification, alkylation, condensation and cycliztaion, dehydration, halogenations, oxidation, sulfonation, amination. Fermentation process; Manufacture of antibiotic - Penicillin, Streptomycin and Erythromycin; Biologicals. Food industry: Types of processing (refining & milling, canning, concentration, freezing, drying, pasteurization); Sugar: Manufacture and refining of cane sugar, decolorization, bagasse, beet sugar.

TEXTBOOKS:

1. *C. E. Dryden, "Outlines of Chemicals Technology", 2nd Edition, Edited and Revised by M. Gopala Rao and M. Sitting, Affiliated East–West Press, 1993.*
2. *M. B. Hocking, "Handbook of Chemical Technology and Pollution Control", 3rd Edition, Academic Press, 2005.*
3. *G. I. Austin, "Shreve's Chemical Process Industries", 5th Edition, Tata McGraw Hill, Singapore, 1990.*

REFERENCES:

1. *Martin B. B. Hocking, "Handbook of Chemical Technology and Pollution", 3rd Edition, Academic Press, 2006.*
2. *M. Bickford, "Kirk-Othmer - Concise Encyclopedia of Chemical Technology", (2-volume set), 4th Edition, Wiley-Interscience, 1999.*

15CHE213 PROCESS HEAT TRANSFER 3 1 0 4

Unit 1

Modes of heat transfer – Fourier's law of heat conduction and applications; Thermal conductivity measurement; Steady state conduction with variable area; Heat transfer coefficient & film theory; Heat transfer in extended surfaces; Heat Transfer to Fluids without phase change: Concepts of heat transfer by convection – Natural and forced convection; Correlations for the calculation of heat transfer coefficients.

Unit 2

Analogies between transfer of momentum and heat – Reynold's analogy, Prandtl and Colburn analogies; Heat Transfer to Fluids with Phase Change – heat transfer from condensing vapors, drop wise film wise condensation, film condensation on vertical surface and horizontal tube bank; Heat transfer to boiling liquids – mechanism of boiling of saturated liquids; Heat exchangers – shell & tube, double pipe, flow patterns, construction and operational features, theory & calculations, energy balances and effectiveness.

Unit 3

Heat exchanger design procedure – Effectiveness - NTU Method – Chart for different configurations; Theory of Evaporation; evaporator types; single effect and multiple effect evaporation; evaporator design considerations; Radiation heat transfer – Emissive power, Black body radiation, Emissivity, Stefan–Boltzman law, Planck's law, radiation between surfaces.

TEXTBOOKS:

1. *Binay K. Dutta, "Heat Transfer – Principles and Applications", PHI Learning Pvt. Ltd., 2001.*
2. *W. L. McCabe, J. C. Smith and P. Harriot, "Unit Operations in Chemical Engineering", 6th Edition, McGraw Hill, 2001.*
3. *J. P. Holman, "Heat Transfer", 8th Edition, McGraw Hill, 1997.*

REFERENCES:

1. *F. P. Incropera, "Fundamentals of Heat and Mass Transfer", 6th Edition, Wiley, 2006.*
2. *J. M. Coulson, and J. F. Richardson, "Chemical Engineering Vol. 1", 4th Edition, Asian Books Private Limited, India, 1998.*

15CHE281 FLUID MECHANICS LAB. 0 0 2 1

Bernoulli's equation for steady flow - verification of energy conservation principle; Determination of coefficient of discharge of flow measuring devices like venturimeter, orificemeter, rotameter; Pipe friction studies- losses in fittings - friction factor; Flow through annular and helical coil pipes - coefficient of friction; Performance characteristics of centrifugal and reciprocating pumps; Flow through packed columns – fluidization - pressure drop in the column; Terminal settling velocity.

15CHE282 MECHANICAL OPERATIONS LAB. 0 0 2 1

Calculating Specific Surface Area and Particle Size using Sieve Analysis, Screen Effectiveness, Verifying crushing laws and energy consumption in Jaw Crusher, Ball mill and Drop weight Crusher, Determining reduction ratio in Roll Crusher, and Drop Weight Crusher, Solid Separation in Cyclone Separator, Calculation thickener area using batch sedimentation experiment, Determining Specific Cake resistance and filter medium Resistance in Filter Press, and Leaf Filter.

15CHE285 CHEMICAL ENGINEERING INSTRUMENTATION LAB. 1 0 2 2

Measurements – Units and Dimensions, Unit Conversions, Significant Figures, Uncertainty in Measurements: Standard Error, Standard Deviation, Sampling and Confidence Intervals; Rating an Instrument – Interval, Range, Resolution, Sensitivity, Detection Limit, Repeatability, Reproducibility, Accuracy and Precision; Graphical Representation of Data – Scatter Plots, Linear, Log-Linear and Log-Log Plots, 3D and Contour Plots, Bar Charts

Pressure Measurement (Two Experiments) – Atmospheric, Gauge, Differential, Vacuum, Barometric Pressure, Static vs. Dynamic Pressure; U-tube Manometer, Capsule Gauge, Thermal Gauge, Capacitive Gauge, Ion Gauge; Safety: Pressure Regulator, Relief Valves, Rupture Disks, Pressure Test and Leak Test;

Temperature Measurement (Two Experiments) – Wet Bulb, Dry Bulb Temperatures and Dew Point; Thermometers, Thermistors, Resistance Temperature Devices (RTD), Thermocouples, Thermopiles, Pyrometers;

Flow Measurement (Two Experiments) – Positive Displacement, Differential Pressure, Variable Area, Mass Flow, Oscillatory, Ultrasonic Flow Meters; Orifice Meters, Venturi Meters, Compressible Flow, Pitot Tubes, Rotameters, Hot Wire Anemometers, Coriolis Flow Meters;

Analysis of Solids and Powders (One Experiment) – Bulk and Particle Density; Particle Size and Size Distribution – Sieve Analysis, Diffraction, Microscopy;

Concentration and pH in Gases and Liquids (One Experiment) – pH Meters, Introduction to Chromatography, Mass Spectrometry, Refractometry, Spectroscopy

TEXTBOOKS / REFERENCES:

1. *G. S. Patience, "Experimental Methods and Instrumentation for Chemical Engineers", Elsevier, 2013.*
2. *V. R. Radhakrishnan, "Instrumentation and Control for the Chemical, Mineral and Metallurgical Processes", Allied Publishers Pvt. Ltd., 1997.*
3. *AlokBarua, "Fundamentals of Industrial Instrumentation", Wiley India, 2011*

15CHE286 CHEMICAL TECHNOLOGY LAB. 0 0 2 1

1. Estimation of the percentage of nitrogen in urea by Kjeldahl's method
2. Determination of the percentage of available chlorine in the given sample of bleaching powder.
3. Determination of acid value and iodine value of different oils (any two)
4. Estimation of saponification value of different oils (any two)
5. Determination of alkalinity and Total fatty matter by Soap analysis (any two)
6. Analysis of Flash point of a given oil (any two)
7. Determination of viscosity by red wood viscometer
8. Estimation of silica and moisture content in cement analysis.
9. Determination of sucrose content in the given sample of sugar
10. Analysis of the percentage of ash and lactose content in the given milk sample.

15CHE301 CHEMICAL REACTION ENGINEERING I 3 0 0 3

Unit 1

Elementary reactions - Rate equation and rate law, temperature dependency of rate of reaction (rate constant) – Arrhenius, Collision and Transition State theories.

Non-elementary reactions, mechanisms of non-elementary reactions – the pseudo steady state hypothesis (PSSH).

Analysis of Batch Reactor Data – Integral and Differential analysis of data, rate parameter estimation using least square analysis and curve fitting.

Unit 2

Design / performance equations for homogeneous and Isothermal systems – Batch, mixed flow and tubular reactors; size comparison of different reactors for single reactions; Rate parameter estimation using experimental data from various reactors.

Combination of reactors for a single reaction; Mixed Flow Reactors in Series; Combined Reactors in Series – Plug flow followed by mixed flow and vice versa. Parallel reactors – feed distribution in parallel reactor configuration; Auto catalytic reactions - Recycle reactors, Optimization of recycle ratio.

Unit 3

Multiple reactions – series, parallel and series-parallel reactions; Conversion and Selectivity; Reactor design for series reactions; Reactor design for parallel reactions; Reactor design for Series-parallel reactions;

Adiabatic reactions; heat of reaction as a function of temperature; Temperature as a function of Conversion and vice versa; Cooling / heating requirements in near-isothermal operation; Effect of temperature on conversion and selectivity in multiple reactions;

TEXTBOOK AND REFERENCE BOOKS:

1. *Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition, John Wiley, 2004*
2. *Scott H. Fogler, Elements of Chemical Reaction Engineering, 4th Edition, Prentice Hall of India, 2000*
3. *G. F. Froment and K. B. Bischoff, Chemical Reactor Analysis and Design, 2nd Edition, John Wiley, 1990*

15CHE302 DIFFUSIONAL MASS TRANSFER OPERATIONS 3 1 0 4

Unit 1

Molecular diffusion in fluids, Fick's Law of diffusion, steady state diffusion under

stagnant and laminar flow conditions. Diffusivity measurement and estimation, multi-component diffusion, diffusion in solids and its applications, eddy diffusion, mass transfer coefficients, theories of mass transfer, analogy equations, application of empirical correlations to known geometry suchas flat plates, wetted wall columns.Concept of mass transfer coefficients, inter phase mass transfer, two film theory, relationship between individual and overall mass transfer coefficients. Mass transfer in fluidized bed, flow past solids and boundary layers.Equipments for countercurrent and concurrent mass transfer operations.

Unit 2

Absorption and stripping – Gas liquid equilibria, Raoults and Henry's laws,Solubility of gases in liquid, choice of solvent; Material balance in countercurrent andconcurrent absorption and stripping, L/G ratio,absorption factor; Equipment for absorption, Graphical and analytical methods for tray column, packed columns for absorption: rate based designs, HTU, NTU and HETP concepts, absorption with chemical reaction. Humidification and dehumidification: vapour liquid equilibria, theory of wet-bulb temperature and adiabatic saturationtemperature, Lewis relation, Lewis relation, psychometric chart, humidification and dehumidification equipments, enthalpy transfer concepts – temperature profiles in humidifier and dehumidifiers theory. Classification and design of cooling towers.

Unit 3

Drying: Solid-gas equilibria, mechanism of drying, drying curves, modes ofdrying operations, classification of dryers, industrial dryers for batch and continuous drying, time of drying in batch operation, estimation of size of rotary dryer based on rate concept.Crystallization:Equilibrium, theories of crystallization, purity, yield, energy requirements, kinetics of crystallization – nucleation and growth; population balance model, MSMPR crystallizer, crystallisation equipment.

TEXTBOOKS:

1. *R. E. Treybal, Mass Transfer Operations, 3rd Edn. McGraw Hill 1981.*
2. *Binay K. Dutta, Principles of Mass Transfer and Separation Processes, PHI Learning Private Ltd, 2013*

REFERENCES:

1. *J. D. Seader, Ernest J. Henley, Separation Process Principles, 2nd Edition, Wiley India, 2011*
2. *Coulson, J. M. and Richardson, J. F. Chemical Engineering Vol. II, 4th Edn., Asian Books Pvt. Ltd. India. 1998.*
3. *McCabe, W. L. Smith, J. C. and Harriot, P. "Unit Operations in Chemical Engineering, 6th Edn, McGraw Hill Edn, 2001.*
3. *J. R. Welty, C. E Wicks, G. L. Rorrer and R. E. Wilson, Fundamentals of Momentum, Heat and Mass Transfer, 4th Edition, Wiley, 2000.*

4. *Foust, A. S. Wenzel, L. A. Clump, C. W. Naus, L., and Anderson, L. B. 'Principles of Unit Operations', 2nd Edn. Wiley, 1980.*
5. *Geankoplis, C. J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2004.*

15CHE303 STATICS AND STRENGTH OF MATERIALS 3 1 0 4

Unit 1

Principles of statics: Introduction to vector approach - free body diagram - forces in plane and space - concurrent forces - resolution of forces - equilibrium of particle. Statics of rigid bodies in two and three dimensions - moment of force - rigid body equilibrium - support reactions. Centroid and centre of gravity; Centroids of lines, areas, volumes and composite bodies - Second moment of area - polar moment of inertia - mass moment of inertia.

Unit 2

Simple Stresses and Strains: Hooke's law - Elastic limit linear strain - lateral strain - Analysis of varying sections - bars of composite sections – Thermal stresses. Shear force and bending moment; Different types of support conditions and loads - Cantilever – simply supported – Over hanging beams, point loads, uniformly distributed loads - Theory of Simple bending; flexural formula.

Unit 3

Torsion of circular sections; Derivation of torsional formula – Assumptions made Power transmitted – Solid and hollow shafts. Complex stress; principal stresses and principal planes - principal strains – graphical method. Thin Shells; Thin cyclindrical shells subjected to internal pressure – Circumferential stress – Longitudinal stress – change in diameter – length-volume – Thin spherical shells. Columns; Axially loaded Columns – Different end conditions – Euler's formula for long columns.

TEXTBOOKS:

1. *R. C. Hibbeler, "Statics and Mechanics of Materials" Prentice Hall, 2013.*
2. *F. W. Cheng, "Statics and Strength of Materials", McGraw Hill India, 2013.*

REFERENCES:

1. *F. P. Beer, E. R. Johnston & D.Mazurek, "Vector Mechanics for Engineers: Statics", McGraw-Hill Higher Education, 2012.*
2. *J. M. Gere and B. J. Goodno, "Mechanics of Materials", CL Engineering, 2012.*

15CHE311 CHEMICAL REACTION ENGINEERING II 3 0 0 3

Unit 1

Steps in heterogeneous reactions – bulk diffusion, internal diffusion, adsorption,

desorption and surface reaction; Rate expressions for different steps in heterogeneous systems; Thiele modulus and effectiveness factor.

Flow regimes in Gas-Solid and Liquid-Solid systems; Estimation of overall mass transfer coefficient in heterogeneous systems; Design of packed-bed, fluidized bed, slurry and trickle bed reactors;

Unit 2

Relative rates of reaction and mass transfer in non-catalytic reactions in Gas-liquid reactions – Hatta number; Effect of gas solubility on rate of reaction;

Models for fluid-solid reactions: Progressive conversion model and Shrinking core model; Rate controlling steps in fluid-solid non-catalytic systems; Reactor design for non-catalytic reactions.

Unit 3

Non-ideal mixing in reactors; Estimation of mean residence time distribution and dispersion in mixing vessels using tracer studies; Dispersion model and Tanks-in Series model.

TEXTBOOK AND REFERENCE BOOKS:

1. *Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition, John-Wiley & Sons Inc., 1999*
2. *Scott H. Fogler, Elements of Chemical Reaction Engineering, 3rd Edition, PHI Limited, 2004*
3. *Peter Harriot, Chemical Reactor Design, Marcel and Dekker Inc., 2003*
4. *Froment, Bischoff and De Wilde, Chemical Reactor Analysis and Design, 3rd Edition, John-Wiley & Sons Inc., 2011*
5. *Hugo A. Jakobsen, Chemical Reactor Modeling: Multiphase Reactive Flows, Springer-Verlag, 2008*

15CHE312 EQUILIBRIUM STAGED OPERATIONS 3 1 0 4

Unit 1

Design of mass transfer equipment based on the concept of equilibrium stage;

Distillation: vapor-liquid equilibria, Raoults law and deviations from ideality, methods of distillation; Equilibrium and operating line concepts; Design calculations by McCabe-Thiele and Ponchon-Savarit methods; Continuous contact distillation (packed tower) design; Extractive and azeotropic distillation, low pressure distillation; Steam distillation; Tray tower equipment.

Unit 2

Absorption: Design of tray tower absorbers; Operating characteristics of stagewise

and differential contactors; Design calculations for single stage, multistage concurrent and countercurrent absorbers.

Liquid-liquid extraction: Equilibrium in ternary systems; Design calculations for batch and continuous extractors, equipment – spray, packed and mechanically agitated contactors; Pulsed extractors, centrifugal extractors.

Unit 3

Leaching: Solid-liquid equilibria; Equipment – batch and continuous types; Calculation of number of stages.

Adsorption and Ion exchange: Theories of adsorption of gases and liquids; Principle of ion exchange; Equipment for batch and continuous operation; Design calculations for adsorption and for ion exchange resins.

Miscellaneous separation processes: Introduction to membrane separation process; Solid and liquid membranes; Reverse osmosis; Electrodialysis.

TEXTBOOKS:

1. *R. E. Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, 1981.*
2. *J. D. Seader and E. J. Henley, Separation Process Principles, 2nd Edition, Wiley, 2005.*

REFERENCES:

1. *J. M. Coulson and J. F. Richardson, "Chemical Engineering Vol. II", 4th Edition, Asian Books Pvt. Ltd, India, 1998.*
2. *W. L. McCabe, J. C. Smith and P. Harriot, "Unit operations of Chemical Engineering", 6th Edition, McGraw Hill, International Edition, 2001.*

15CHE313 MATERIALS TECHNOLOGY 3 0 0 3

Unit 1

Basics of Materials Structure: crystal systems – space lattice – miller indices of atomic planes and directions – small problems in crystallography – crystal defects point, line and surface defects. Mechanical Behaviour of Materials: stress-strain curve – elastic deformation - characteristics of elastic deformation - atomic mechanism of elastic deformation - inelastic deformation - strain time curves – viscous deformation - plastic deformation - slip and twinning - Schmidt's law - critical resolved shear stress – Strengthening mechanisms; work hardening - grain boundary hardening, dispersion hardening.

Unit 2

Mechanical Testing and Fracture of Materials: Tensile test - stress–strain curves for ductile and brittle materials – proof stress – Compression test – Hardness test

– Impact test – Fatigue test – S-N curve – Creep; primary, secondary and tertiary creep - Fracture: Ideal fracture stress – brittle fracture – Griffith's theory cup and cone type fracture Phase Diagrams: solid solution – intermetallic compound, cooling, curves, non-equilibrium cooling - phase rule - Equilibrium diagrams – isomorphous - eutectic, peritectic and eutectoid reactions with examples - Iron-Iron carbide phase diagram.

Unit 3

Engineering materials: steels and cast irons - properties and applications - Heat treatment of steels: Annealing – Normalizing Hardening -Tempering matempering – Austempering – Hardenability and its testing – TTT diagram – Surface hardening of steels – carburising, nitriding, induction hardening. Effect of alloying elements on steel - Non-ferrous alloys – copper-aluminum – Magnesium, nickel and zinc-Composite materials – Ceramics.

TEXTBOOKS:

1. *R. Balasubramaniam, "Callisters Materials Science and Engineering", Wiley, 2013.*
2. *W F Smith, J Hashemi, R Prakash, "Materials Science and Engineering", McGraw Hill 2008.*

REFERENCES:

1. *L H Van Vlack, Elements of Materials Science and Engineering, Pearson India 2008*
2. *D. R .Askeland, P. P Fulay, W. J .Wright,The Science and Engineering of Materials, CL Engineering 2012*

15CHE314 PROCESS DYNAMICS AND CONTROL 3 1 0 4

Unit 1

Laplace transformation, transform of standard functions, derivatives and integrals; Open–Loop systems, first order systems: concept of transfer functions, transient response for standard input functions, physical examples of first order systems, first order systems in series, linearization and its application in process control, second order systems and their dynamics, transportation lag.

Unit 2

Closed loop control systems, development of block diagram for feedback control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers; transient response of closed – loop control systems; stability of control systems:Routh-Hurwitz criterion, root locus diagrams.

Unit 3

Frequency response of closed – loop systems,control system design by frequency response techniques, bode diagram and stability criterion, tuning of controller

settings.Introduction to advanced control systems - cascade control, Feed-forward control; Control of chemical processes.

TEXTBOOKS:

1. *D. Coughanowr, "Process Systems Analysis and Control - 2nd Edn., McGraw Hill, New York, 1991.*
2. *G. Stephanopoulos, "Chemical Process Control", 8th Edn, Prentice Hall of India. 2009.*

REFERENCE BOOKS:

1. *Dale E. Seeborg, Thomas F. Edgar, Duncan A. Mellichamp, Francis J. Doyle, Process Dynamics and Control, 3rd Edition, John Wiley and Sons, 2011*
2. *Peter Harriot, Process Control, Tata McGraw Hill, 2008*

15CHE381 HEAT TRANSFER LAB. 0 0 2 1

Thermal conductivity of solid materials, transient heat conduction, electrical analogies, natural convection, forced convection, heat transfer in pool boiling, condensation heat transfer, steady and un-steady state heat transfer through submerged coils in agitated vessels. Radiation heat transfer, characteristics and efficiency of heat transfer equipments such as heat exchangers, jacketed pans and evaporators.

15CHE382 STRENGTH OF MATERIALS LAB. 0 0 2 1

Tensile test on metals and wires - determination of tensile strength, modulus of elasticity, percentage elongation; Hardness tests - Rockwell, Brinell hardness number; Impact test - Izod and Charpy - impact strength, energy and modulus estimation: Compression test; Torsion test on shafts - determination of Shear stress and modulus of rigidity; Static bending test – fibre stress at limit of proportionality, resilience, modulus of elasticity; Fatigue test - S-N curves; Deflection test on beams; Double shear test.

15CHE385 CHEMICAL REACTION ENGINEERING LAB. 0 0 2 1

Lecture on RTD studies; Study of kinetic expressions for first and second order reactions,kinetic studies in batch reactor, Semi batch reactor, Sono batch reactor, CSTR, PFR, Combined reactor in series,RTD study in CSTR in series, RTD study in a PFR.

15CHE386 MASS TRANSFER LAB. 0 0 2 1

Measurement of Diffusion coefficient, measurement of mass transfer coefficient, Concentration profile, Wetted wall column, Ternary Liquid-liquid Equilibrium, Leaching, Extraction in packed and plate columns. Steam distillation, Simple distillation, Distillation

in packed columns. Absorption Isotherms Drying rate measurements. Characteristics and Efficiency of mass transfer equipments.

15CHE390 / 15CHE490 LIVE-IN-LAB. 3 cr

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or rural sites during the vacations (after fourth semester or sixth semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth or seventh semester. The objectives and projected outcome of the project should be reviewed and approved by the Dept. chairperson and a faculty assigned as the project guide. On completion of the project, the student shall submit a detailed project report. The report shall be evaluated and the students shall appear for a viva-voce test on the project.

15CHE391 PROJECT BASED LEARNING - PHASE I 1 cr

Students will study a core Chemical engineering elective and discuss the theoretical (analytical and design) aspects of the subject matter. A minimum of two homework assignments will be given.

At the beginning of the semester, the instructor in consultation with the project group, will assign a project topic (from the elective selected) so that it covers the key concepts associated with the elective subject.

The projects could be based on design, process operational understanding, process optimization, mathematical representation of process, flowsheet simulations, or a research question aimed at developing new understanding on a topic or any other innovative topic.

By the end of the semester the student must submit a report with project objective(s), project plan, methodology, any special requirements (in terms of materials, equipment, and software), and key areas of learning - in consultation with the instructor.

15CHE396 PROJECT BASED LEARNING - PHASE - II 2 cr

Students will apply the concepts that they have studied in Project Based Learning - I, and proceed with executing the project as per plan. The instructor provides guidance through tutorial classes to help the students to master problem solving and analytical aspects. There will be requirement of literature review report, two mid-project reports and a final report, each of which will be used towards course evaluation.

15CHE401 PROCESS DESIGN AND INTEGRATION 3 0 0 3

Unit 1

Chemical process design process, Hierarchy of chemical process design and integration, Newdesign vs. retrofit, approaches, Heuristics for process design. Conceptual Process Synthesis – Diagrams for understanding chemical processes, Structure and hierarchical synthesis of flow sheets.

Reactor Network Synthesis - Reactor type and conditions for reaction systems, geometric techniques for synthesis of reactor networks.

Unit 2

Separation system Synthesis – Distillation column sequencing for ideal liquid mixtures, Separation system structure for non-ideal mixtures using distillation / residue curves. Reaction, Separation and recycle systems for batch and continuous processes.

Unit 3

Heat Exchanger Network: Synthesis using Pinch Technology – Targets for minimum utilities, area, total cost. Pinch design method for heat exchange network design, Evolutionary synthesis for minimum number of exchanges design. Heat integration of process equipments.

TEXTBOOK:

Robin Smith, Chemical Process Design and Integration, John Wiley & Sons Ltd., New Delhi, 2014.

REFERENCES:

1. *Warren D. Seider, J. D. Seader, Daniel R. Lewin, Soemantri Widagdo, Product and Process Design Principles: Synthesis, Analysis and Design, 3rd Edn, Wiley, 2010*
2. *Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwitz, Analysis, Synthesis, and Design of Chemical Processes, 3rd Edn, Pearson Education, 2008*
3. *Biegler, L. T., Grossmann, I. E., and Westerberg, A. W. "Systematic Methods for Chemical Process Design", Prentice-Hall, 1997.*
4. *Douglas, J. M. "Conceptual Design of Chemical Processes", McGraw Hill, 1988.*
5. *Harry Silla, Chemical Process Engineering Design and Economics, Marcel Dekker, Inc., New York, 2003*

15CHE402 PROCESS EQUIPMENT DESIGN AND DRAWING 2 0 2 3

Design and drawing of chemical engineering equipments – hydrodynamic design, process design, mechanical design and drawing of the following equipments:

Unit 1

Pressure Vessels, Storage Tanks, Heat exchangers, Condensers.

Unit 2

Evaporators, Dryers, Cooling towers, Crystallizers.

Unit 3

Absorption columns, Distillation columns, Extraction columns, Reactors.

TEXTBOOKS:

1. *M. V. Joshi and V. V. Mahajan, "Process Equipment Design", 3rd Edition, MacMillan India Ltd., 1996.*
2. *J. M. Coulson and J. F. Richardson, "Chemical Engineering Vol. 6", Asian Books Pvt Ltd, India, 1998.*

REFERENCES:

1. *R. H. Perry, D. W. Green and J. O. Maloney, "Perry's Chemical Engineers Handbook", 7th Edition, 1997.*
2. *S. D. Dawande, "Process Design of Equipments", Central Techno Publications, Nagpur, 2000.*
3. *"Indian Standard Specifications", IS: 2712-1998; IS: 2825-1969; IS: 3233-1965; IS: 4049-1996; IS: 4179-1967;IS: 4503-1967; IS: 4865-1968 Indian Standards Institution, New Delhi.*
4. *S. Tickoo, "AUTOCAD 2000", Galgotia Publications, New Delhi, 2001.*
5. *D. Kern, "Process Heat Transfer", McGraw Hill, 1999.*

15CHE403 TRANSPORT PHENOMENA 3 1 0 4

Unit 1

Review of basic vector algebra and introduction to tensors, Macroscopic – Microscopic-Molecular views of phenomena; Momentum Transport: viscosity, pressure and temperature effect on viscosity of gases and liquids, Newton's law of viscosity, mechanisms of momentum transport, non-Newtonian fluids & power-law models, derivation of velocity profile using shell balance method, velocity distributions in falling film and circular tube; equations of continuity, motion, and mechanical energy; use of equations of change to solve flow problems; unsteady viscous flow.

Unit 2

Energy Transport: Thermal conductivity, temperature and pressure effect on thermal conductivity of gases and liquids, Fourier's law, mechanisms of energy transport, derivation of temperature profile using shell energy balance (with electrical, nuclear, viscous and chemical heat source); temperature distribution in solids and laminar flow, heat conduction through composite walls, and cylinders; Combined energy flux vector; equation of energy (alternate forms) - applications to specific systems (forced convection laminar flow in tube, tangential flow in annulus, transpiration cooling); unsteady heat conduction in solids.

Unit 3

Mass Transport: Diffusivity, mechanisms of mass transport, concentration distribution

in solids and in laminar flow, Fick's law, temperature and pressure effect, theory of diffusion in gases and liquids, types of diffusion (ordinary, thermal, pressure, and forced), mass and moles transport, mass & molar average velocities; shell mass balances; concentration distribution through stagnant gas, diffusion in heterogeneous and homogeneous chemical reaction, falling film; Equations of change for multicomponent systems and concentration distribution in turbulent flows: derivation of equation of continuity for binary mixture.

TEXTBOOK:

R. B. Bird, W. E. Stewart and E. W. Lightfoot, "Transport Phenomena", 2nd edition, John Wiley, 2002.

REFERENCES:

1. *R. S. Brodkey and H. C. Hershey, "Transport Phenomena", McGraw Hill, 1988.*
2. *J. R. Welty, R. W. Wilson and C. W. Wicks, "Fundamentals of Momentum, Heat, and Mass Transfer", 3rd Edition, John Wiley, 1984.*
3. *J. S. Slattery, "Advanced Transport Phenomena", Cambridge University Press, 1992.*

15CHE431 BIOCHEMICAL ENGINEERING 3 0 0 3

Unit 1

Introduction: History and need for biochemical Engineering; Essential life sciences: Biomolecules; Microbial world; Metabolism and Bioenergitics; Cell and their function; Enzymes and enzyme kinetics: Enzymes fundamental concepts, Classification of enzymes; Industrial application of enzymes; Industrially important enzymes; Mechanism of enzymatic reactions; Kinetics: Michaelis-Menten and Briggs Haldane equation; Evaluation of kinetic parameters; Enzymes inhibition; Factors affecting the reaction rates;

Unit 2

Immobilized enzyme: Medical and analytical application of immobilized enzyme; Techniques; Immobilized Enzyme kinetics: Effect of mass transfer resistance. Microbial kinetics: Typical growth characteristics of microbial cells, factors affecting growth; Monod's equation; Transport in microbial system: Newtonian and Non-Newtonian behaviour of broths; Agitation and Mixing; Power consumption; Gas–Liquid transport in cells; Transfer resistances; Mass transfer coefficients and their role in scale–up of equipments.

Unit 3

Bioreactors: Batch and continuous types; High performance bioreactors; Downstream processes and effluent treatment: Recovery and purification of products, different unit operations in down streaming with special reference to membrane separations; Extractive fermentation; Anaerobic treatment of effluents; Typical industrial examples for downstream processing and effluent disposal.

TEXTBOOK:

J. E Bailey and D. F. Ollis, "Biochemical Engineering Fundamentals", McGraw Hill, International Edition, 2nd Edition, New York, 1986.

REFERENCE BOOKS:

1. *J. M. Lee, "Biochemical Engineering", 1st Edition, Prentice Hall, 1992*
2. *H. W. Blanch and D. S. Clark, "Biochemical Engineering", 2nd Edition, CRC Press, 1997.*
3. *M. L.Shuler and F. Kargi, "Bioprocess Engineering Basic Concepts", Prentice Hall of India, 2002.*
4. *D Mukesh and N. G. Sathyanarayana, "Biochemical Engineering", PHI Learning Pvt. Ltd., 2007*

15CHE432 CHEMICAL PROCESS MODELING AND SIMULATION 3 0 0 3

Unit 1

Chemical engineering problems; Modeling – Steps involved; Variables – Stream, Unit, and Process variables; Constraints – Conservation relations, Sources and sinks, Material, Energy, Momentum balances; Equilibrium relations, Constitutive models; Common assumptions in modeling; Types of models – Lumped, Distributed, and Staged parameter models; Design variables – Characteristic length, time, velocity, temperature, mass, force; Change of variables; Dimensionless groups in modelling.

Filling and draining tanks: Steady and unsteady states, Varying inlets and outlets, Level and flow control; Mixing tanks: Two and multiple streams, Composition control; Heated tank: Jacketed kettle with steam condensation, Electrical heating, Phase change; Isothermal CSTR: 1st and 2nd order reactions, Enzyme kinetics; Non-isothermal CSTR; Centrifugal separation.

Unit 2

Shell balances: Flow through a pipe, Continuity equation; Compressible fluid flow, Shock waves; Double-pipe heat exchanger: Steam condensing in shell/tube, Parallel vs counter flow; Pipeline flashing; Isothermal PFR: Component continuity equation, 1st and 2nd order reactions; Non-isothermal PFR: 1st and 2nd order reaction.

Triple effect evaporator; Binary distillation: continuous and batch columns; Multicomponent distillation: Underwood-Gilliland model; Gas absorption into a laminar liquid jet; Tray tower absorption: Kremser-Brown-Sauders equation, rigorous models; Reactive absorption in a wetted wall column; Multistagecountercurrent liquid-liquid extraction.

Unit 3

Selected Systems from the following: Multiple steady states and Stability: Isothermal and Non-isothermal CSTR; Temperature control in a non-isothermal PFR; Packed bed reactor; Polymerization: Bulk and Suspension polymerization; Membrane separation – Cross flow and reverse osmosis; Activated sludge process –

secondary bioreactor; Pyrolysis of plastic; Chemical vapor deposition; Continuous, multicomponent distillation column; Dry flue gas desulfurization; Ball mill; Rotary kiln.

TEXTBOOK / REFERENCE:

1. *W. L. Luyben, Process Modeling, Simulation and Control for Chemical Engineers, 2nd Edition, McGraw Hill, 1996.*
2. *C. L. Smith, R. W. Pike and P. W. Murrill, Formulation and Optimization of Mathematical Models, International Textbook Company, USA, 1970.*
3. *L. T. Biegler, E. I. Grossman and A. W. Westerberg, Systematic Methods of Chemical Process Design, Prentice Hall, 1997.*

15CHE433 ENVIRONMENTAL ENGINEERING FOR PROCESS INDUSTRIES 3 0 0 3

Unit 1

Water Pollution Control: wastewater characteristics: physical, chemical and bacteriological, Types of pollutants in waste water of chemical industries, Methods of sampling, preservation of samples and analysis. Methods for the treatment of liquid wastes: Physical, chemical and biological methods, Selection and design of equipments. Physical treatment: pre-treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and flocculation. Chemical Treatment: Anaerobic with special reference to UASB and aerobic treatment biochemical kinetics, trickling filter, activated sludge process, lagoons, aeration systems, fluidized bed bioreactors; Disinfection, Ion exchange, Electro-dialysis, Reverse Osmosis.

Pollution control in selected process industries – fertilizer industries, petroleum refineries and petrochemical units, pulp and paper industries, Tanning industries, Sugar industries, Dairy, Alcohol industries, Electroplating and metal finishing industries, Radioactive wastes, ranking of wastewater treatment alternatives, Case Studies.

Unit 2

Solid Wastes Management: Characterization of wastes-hazardous and non-hazardous wastes. Waste disposal and management laws and guidelines; Problems of collection and handling; various processing techniques used in solid waste management - treatment, disposal, utilization and management; valueextraction from the wastes;

Industrial waste management and Pollution Prevention: Process modification, alternative raw material, recovery of by co-product, recycle and reuse of waste, energy recovery and waste utilization.

Unit 3

Air Pollution Control: Sources and effects of air pollutants on physical environment and living systems, Methods of measuring and sampling of gaseous and particulate pollutants, meteorological aspects of air pollution,effects, Selection and Design of particulate and gaseous pollution control equipment; mechanical separation, Bag filter, cyclone separator, electrostatic precipitation, wet gas scrubbing, adsorption and absorption.

TEXTBOOKS / REFERENCES:

1. *C. S. Rao, "Environmental Pollution Control Engineering," 2nd Edition, New Age International Publishers, 2006.*
2. *G. Kiely, "Environmental Engineering", Special Indian Edition, Tata McGraw-Hill, 2009.*
3. *G. Tchobanoglous, F. L. Burton, and H. D. Stensel, "Wastewater Engineering: Treatment and Reuse", 4th Edition, McGraw Hill Science, 2002.*
4. *S. P. Mahajan, "Pollution Control in Process Industries", Tata McGraw Hill, 2001.*
5. *A. P. Sincero and G. A. Sincero, "Environmental Engineering: A Design Approach", Prentice Hall, 1995.*
6. *H. S. Peavy, D. R. Rowe, and G. Tchobanoglous, "Environmental Engineering", 7th Edition, McGraw Hill, 1987.*
7. *M. N. Rao and H. V. N. Rao, "Air Pollution", Tata McGraw Hill, 2001.*
8. *F. Kreith and G. Tchobanoglous, "Handbook of Solid Waste Management", 2nd Edition, McGraw Hill, 2002.*

15CHE434 INTERFACIAL SCIENCE AND ENGINEERING 3 0 0 3

Unit 1

Introduction – colloids, surfaces and interfaces, Colloids - classifications and characterizations. Colloids - preparation and purification methods - Surfaces and interfaces – definitions, description of different surface and interfaces, applications of interfacial engineering - Surface, interfacial tensions and measurement of interfacial tension using different methods - Surface properties.

Attractive forces and van der Waals interactions - Columbic forces and ionic, dipole interactions. Van der Waals forces in polar and non-polar media - Electrostatic and Electrokinetic theories.

Source of interfacial formation and electrical double layer (EDL) - Helmholtz model, Gouy-Chapmanmodel, Debye–Hückel theory on EDL, EDL thickness - Surface potential, Zeta potential, pH effects, calculations - Electroosmosis and Electrophoresis, types, applications.

Unit 2

Capillary theories, Capillary driving forces in liquid–fluid systems, Solid–Liquid–

Fluid Systems: The Effect of Contact Angle - Capillary Flow and Spreading Processes, coefficients, petroleum recovery, measurement of capillary driving forces - Surface tension gradients, marangoni flow, contact angle hysteresis, dynamic contact angles, Practical capillary systems – wetting in fibers, water proofing, wicking process and detergency.

Adsorption – Gibbs surface excess, adsorption equation for Solid-Fluid interfaces, Gibbs adsorption isotherm – Physisorptionvs Chemisorption, Thermodynamic considerations, heterogeneous catalysis.

Catalytic poisons, promoters and adsorption isotherms at S-V interfaces, Langmuir, Freundlich, BET adsorption isotherms and surface area calculations, adsorption at S-L interfaces - Adsorption isotherms in solid–liquid systems, nature of the adsorbent surface, environmental effects - Colloidal stability – Coagulation, flocculation, mechanism for colloidal formation.

Unit 3

Colloidal behaviour, Lennard–Jones 6–12 potential, attractive forces, sources of colloidal stability, critical coagulation concentration -Coagulation kinetics - fast and slow, Smoluchowski equation, DLVO theory, reversible flocculation.

Emulsions - formation, emulsification methods-Emulsifiers and Stabilizing agents, types, functions.

HLB number, PIT and Application of HLB and PIT in Emulsion Formulation - Association colloids - vesicles, micelles and membranes -Surfactant solubility, krafft temperature, and cloud point - Surfactant liquid crystals, micelles, micelle formation - Critical micelle concentrations (CMC) - factors affecting CMC, additives - Vesicles and bilayer membranes – definitions, applications.

Optical properties - Light scattering, turbidity, light scattering theories - Scattering by small particles, large particles, Rayleigh, Debye and Mie scattering of particles - Foams, Aerosols, Foam stability and microfoams - Rheological properties of colloidal dispersions - viscosity, newtonian and non-newtonian fluids, Electroviscous effects.

REFERENCE / TEXTBOOKS:

1 *Drew Myers, Surfaces, Interfaces, and Colloids: Principles and Applications. 2nd Ed., Wiley-VCH, 1999*
2 *D. J. Shaw, Colloid & Surface Chemistry, 4th Edition, Butterworth-Hienemann, 2003,*
3 *Intermolecular and Surface Forces, Jacob N. Israelachvili, Academic Press, 1992*

15CHE435 MATERIAL CHARACTERIZATION AND SPECTROSCOPIC METHODS 3 0 0 3

Unit 1

Imaging microscopies and Image analysis: Optical Microscopy, Scanning electron microscopy, Scanning probe microscopy, X-ray microscopy and Transmission electron microscopy, Image analysis.

Unit 2

X-ray-diffraction, properties of x-rays, review of crystal systems and miller indices, stereographic projections, Laue conditions, braggs conditions, diffraction methods, phase identifications, electron diffraction methods.

Unit 3

EDAX, XPS, scattering methods, Thermal and Thermomechanical analysis: differential scanning calorimetry and Differential thermal analysis. Thermogravimetric analysis, Dynamic mechanical analysis and TMA.

REFERENCE / TEXTBOOKS:

1. *Yang Leng, Materials Characterization: Introduction to Microscopic and Spectroscopic Methods 2013, Wiley VCH; ISBN-10: 3527334637, ISBN-13: 978-3527334636.*
2. *B D Cullity and S R Stock, Elements of X-ray diffraction, 3rd Ed., Prentice Hall 2001*
3. *K P. Menard Dynamic mechanical analysis: A practical introduction, CRC press, 1999*

15CHE436 MODERN SEPARATION METHODS 3 0 0 3

Unit 1

Introduction to binary distillation – The concept of K-factor; Multi-component distillation – Design, Models for multi-component design; Design of distillation columns for more than one feed stream; Pressure drop and tray-efficiency calculations.

Unit 2

Nature of Synthetic Membranes, General membrane Equation, Cross-Flow Microfiltration, Ultrafiltration, Reverse Osmosis, Membrane Modules and Plant Configuration, Membrane Fouling, Electrodialysis, Reverse Osmosis Water Treatment Plant, Pervaporation, Liquid Membranes.

Gas Separations - Chromatographic Separations: Elution Chromatography, Band Broadening and Separation Efficiency, Types of Chromatography, Large Scale Elution Chromatography, Selective Adsorption of Proteins, Simulated Countercurrent Techniques, Pressure Swing Adsorption.

Unit 3

Combined Reaction and Separation, Comparison with other Separation Techniques - Ionic Separations: Ion Exchange Resins, Resin Capacity, Equilibrium, Exchange Kinetics; Ion Exchange Equipments - Other Techniques: Supercritical Fluid Extraction, Oil Spill Management; Industrial Effluent Treatment by Modern Techniques. Reactive Extraction, Reactive Distillation.

REFERENCES:

1. *J. D. Seader and E. J. Henley, "Separation Process Principles", 2nd Edition, Wiley, 2005.*
2. *R. W. Baker, "Membrane Technology and Applications", John Wiley & Sons Ltd, UK, 2004.*
3. *P. C. Wankat, "Separation Process Engineering", 2nd Edition, Prentice Hall, 2006.*
4. *R. W. Rousseau, "Handbook of Separation Process Technology", Wiley-Interscience, 1987.*
5. *J. M. Coulson and J. F. Richardson, "Chemical Engineering - Volume 2", 5th Edition, Butterworth-Heinemann, 2002.*
6. *Y. Osada and T. Nakagawa, "Membrane Science and Technology", Marcel Dekker, 1992.*
7. *Relevant journal publications.*

15CHE437 NANOSCIENCE AND NANOTECHNOLOGY 3 0 0 3

Unit 1

Nanotechnology Fundamentals - Atomic structure, molecules and phases, surfaces, biosystems, metals, and other materials.

Molecular recognition, nanostructure preparation techniques, top-down and bottom up approach, self-assembly, nano manipulations – overview.

Familiar Nanostructures – SAMs, monolayer protected nanoparticles, quantum dots and core-shell nanoparticles, preparations, characterizations and applications.

Unit 2

Nano fabrication methods: Top-down approach – nanolithography techniques – dip pen, projection optical, e-beam, Extreme UV, proximity x-ray and MBE.
Bottom-up approach: self-assemblies – hydrogen bonded, biomimetic and dimensional nanoparticle arrays.

Carbon nanomaterials - Carbon nanotubes and fullerenes: Formation and properties of nanotubes, fullerenes, characterizations and their applications in electronics and energy storage.

Molecular switches –monomolecular in solutions, on surfaces (electron, pH and light driven switches).

Unit 3

Micro/ Nanoelectronics (Nanowires: transistors, LEDs, Lasers, photodetectors).

Nano-Bio Technology (Lipid and lipid templates, selfassembled monolayers, biological computing, Protein Engineering, biosensors, drug delivery, PDT), Social implications of nanotechnology.

REFERENCE / TEXTBOOKS:

1. *Massimiliano Di Ventra, Stephane EvoyandJames R. Heflin, Jr, "Introduction to Nanoscale Science and Technology" Kluwer Academic Publishers, 2004*
2. *T. Pradeep, Nano: The Essenstials / Understanding Nanoscience and Nanotechnology, Tata Mcgraw Hill Publishing Company Limited, 2007*
3. *Cristian Contescu, Karol Putyera, DekkerEncyclopaedia of Nanoscience and Nanotechnology, 2nd Edition, CRC Press Publications, 2009, ISBN 978 0 8493 9639 7 (six volume set)*

15CHE438 PETROLEUM REFINING AND PETROCHEMICAL TECHNOLOGY 3 0 0 3

Unit 1

Petroleum refining: Crude oil distillation process – thermal conversion processes. Conventional thermal cracking – vis-breaking and design variables of vis-breaking – coking: Fluid coking, flexi coking, delayed coking and hardware considerations – catalytic conversion processes -fluid catalytic cracking with special reference to catalyst and reactor design configurations – hydro-treating, hydrodesulphurization and hydro-cracking – Reforming: process, catalyst, reactor design configuration – alkylation – isomerization – lube oil manufacturing process, solvent – de-asphalting, solvent de-waxing and hydro finishing – production of PET, waxes and bitumen.

Unit 2

Petrochemical technology: Petrochemical industry overview, primary raw materials for petrochemicals, first generation petrochemicals – hydrocarbon intermediates and their production, non-hydrocarbon intermediates, olefin production, processing of olefins C4& C5 cut from steam cracking and fluid cracking.

Unit 3

Aromatics production, second generation petrochemicals from: methane and synthesis gas derivatives, ethylene and ethylene derivatives, propylene and propylene derivatives, C4 and C5 derivatives, aromatics – benzene, toluene and xylene derivatives – third generation petrochemicals – polymers, elastomers, polyurethanes and synthetic fiber.

TEXTBOOKS:

1. *Ram Prasad, "Petroleum Refining Technology", Khanna Publishers, Delhi, 2000.*
2. *J. H. Gary, G. H. Handwerk and M. J. Kaiser, "Petroleum Refining Technology and Economics", 5th Edition, CRC Press, New York, 2007.*
3. *G. D. Hobson and W. Pohl, "Modern Petroleum Technology", 6th Edition, Wiley, New York, 2000.*
4. *B. K. Bhaskara Rao, "A Text on Petrochemicals", Khanna Publishers, New Delhi, 2008.*

REFERENCES:

1. *R. A. Meyers, "Handbook of Petroleum Refining Processes", 2nd Edition, McGraw Hill, New York, 1996.*
2. *J. A. Moulijin, M. Makkee and A. Van Diepen, "Chemical Process Technology", Wiley, New York, 2001.*
3. *I. D. Mall, "Petrochemical Process Technology", Macmillan India Ltd, New Delhi, 2007.*
4. *Sami Matar and Lewis F Hatch, "Chemistry of Petrochemical Processes", Gulf Publishing Company, Houston, Texas, 2000.*

15CHE439 POLYMER COMPOSITES 3 0 0 3

Unit 1

General introduction to composite materials: Concept and definition, classification of composites (CMC, MMC, PMC).Functional roles of reinforcement and matrix and importance of interface. Polymer matrix composites (PMCs): Fiber reinforced and particulate filled polymer composites. Reinforcements (glass, carbon/graphite, Kevlar), Matrices - Thermoset matrices - polyesters, epoxides, phenolics, vinyl esters, polyimides, cyanate esters - Thermoplastic matrices. Choice of reinforcements and matrices for different application needs.

Unit 2

Fiber reinforced polymer composites (FRPs): Basic rule of mixtures, stress-strain relationships. Tailoring of structural properties through laminar-sequencing and choice of fiber fractions/fiber orientations, to meet design requirements. Effect of environmental conditions on properties. Mechanical behaviour of FRP composites: Fiber controlled and matrix dependent properties (tensile, compressive, shear). Experimental determination of composite properties by standard test methods. Composite constructions: Monolithic composite laminates: unidirectional and bidirectional, multi-axial, 3D, filament wound and braided types.

Unit 3

Composite precursors: SMCs, DMCs, BMCs prepreg materials and their choice in specific applications. Fabrication processes for FRP Composites: hand layup, spray up, vacuum bag moulding, compression moulding, filament winding, braiding, pultrusion, RTM, RIM, RRIM, RFI, autoclave moulding, injection moulding etc. Room temperature and hot curing of composites, Joining composite elements and repairs, Recycling of polymer composites.

TEXTBOOKS:

1. *B. Astrom, "Manufacturing of Polymer Composites", CRC Press, 1997.*
2. *P K Mallick, "Fiber-Reinforced Composites: Materials, Manufacturing, and Design", CRC Press, 2007.*

REFERENCES:

1. *F. C. Campbell (Ed), Manufacturing processes for advanced composites, Elsevier, 2004.*
2. *S T Peters (Ed.), "Handbook of Composites", Springer, 1998.*

15CHE440 POLYMER MATERIALS - STRUCTURE PROPERTY RELATIONS 3 0 0 3

Unit 1

Structure of polymers – thermoplastic – thermoset, rubber - Linear, branched, crosslinked, and network polymers - Homochain and hetero atomic chain polymers - Copolymers - Linear and cyclic arrangement - Prediction of polymer properties, group contribution techniques, topological techniques - Volumetric properties - molar volume, density, Van der Waals volume - Coefficient of linear thermal expansion and volumetric thermal expansion - Pressure volume temperature (PVT) relationship.

Mechanical properties - Stress-strain properties of polymers - Effect of polymer structure on modulus of elasticity, tensile strength, flexural strength, impact strength, yield strength, fracture toughness - Crazing in glassy polymers - Ductile brittle transition. Effect of additives on mechanical properties of polymers - Creep, stress relaxation, and fatigue.

Unit 2

Thermodynamic and transition properties - Transition temperature in polymers, glass transition (Tg), melt transition (Tm), relationship between Tg and Tm - other transitions like ß-transitions, upper and lower glass transition temperatures - Prediction of Tg and Tm of polymers by group contributions.Calorimetric properties - Heat capacity, specific heat, latent heat of crystallization and fusion, enthalpy and entropy - Calculation of heat capacities of polymers.

Electrical and optical properties - Effect of polymer structure on dielectric constant, power factor, dissipation factor, and loss factor - effect of frequency of voltage and temperature on dielectric properties - Prediction of molar polarization and effective dipole moment. Effect of additives on electrical properties of polymers.

Unit 3

Optical properties - Effect of polymer structure on optical properties - clarity, transparency, haze, transmittance, reflectance, and gloss - Prediction of refractive indices of polymers by group contributions.

Chemical Properties - Cohesive energy, cohesive energy density, solubility parameter, determination of solubility parameter of polymers - Prediction of solubility parameter - Effect of polymer structure on solubility in solvents and oils - Influence of structure in prediction of flame retardancy, water repellency - Chemical resistance of polymers - Polymer toxicity.

TEXTBOOKS:

1. *J. A. Brydson, "Plastics Materials" Butterworth- Heinemann – Oxford, 7th Ed., London, 1999*
2. *Maurice Morton, "Rubber Technology", 3rd Ed, Kluwer Academic Pub, Dordrecht, Netherlands, 1999*
3. *Manas Chanda and Salil K. Roy, "Plastics Technology Handbook", CRC Press, Atlanta, 2007*

REFERENCE BOOKS:

1. *D. W. Van Krevelen and P. J. Hoftyzen, "Properties of Polymer", 3rd Edition Elsevier Scientific Publishing Company Amsterdam – Oxford – Newyork. 1990.*
2. *Jozef.Bicerano, "Prediction of Polymer Properties", Second Edition, Marcel Dekker Inc. New York, 1995.*

15CHE441 POLYMER PROCESSING 3 0 0 3

Unit 1

Physical Basis of Polymer Processing – Mixing - distributive and dispersive mixing equipments. Extrusion - Features of a Single Screw Extruder, Analysis of Flow, Aspects of Screw Design, Operating Point. Twin Screw Extrusion - Processes – Pipe, Profile, Blown Film, Wire and Cable coating, Fibre, Film and sheet extrusion, Co extrusion - Melt Fracture – Sharskin-Die swell.

Unit 2

Injection Moulding – Principles - Moulding Cycle - Reciprocating Screw injection Moulding Machine - Types of Clamping Units - PVT diagram - Aspects of Product Quality - Hot Runner Moulding - Gas Assisted Injection Moulding. Blow Moulding – Principles - Injection Blow Moulding – Extrusion Blow Moulding – Stretch Blow Moulding - Trouble shooting – Thermoforming - Vacuum Forming - Pressure Forming - Material Stress and Orientation - Applications in Packaging.

Unit 3

Compression and Transfer Moulding - Types of Moulding Machines - Transfer Moulding - Trouble shooting – Comparison. Polymers in Rubbery State - Calendering process - Types of Calendars, Roll Deflection and Cambering - Rotational Moulding - Types of machines, Moulds, Materials. Fibre Reinforced Plastics – Materials - Layup processes - SMC, DMC - Resin Transfer Moulding - Pultrusion, Bag Moulding Processes - Filament Winding. Joining and machining of Plastics - Welding of Plastics - Ultrasonic, Induction, Hotplate, High Frequency. Solvent Cementing - Adhesive Bonding.

TEXTBOOKS:

1. *B. Strong, "Plastics: Materials and Processing", Prentice Hall, 2012.*
2. *D. H. Morton-Jones," Polymer Processing", Chapman & Hall, 1989.*

REFERENCES:

1. *C. A. Harper (Ed), "Handbook of Plastic Processes", John and Wiley 2006.*
2. *M. L. Berins (ed.), "Plastics Engineering Handbook of The Society of The Plastics Industry", Springer, 2012.*

15CHE442 PROCESS INSTRUMENTATION 3 0 0 3

Unit 1

Introduction, general principles of measurement, classification of instruments, elements of an instrument, direct and inferential measurement; Static and dynamic characteristics of instruments,errors in measurements & error Analysis; Classification of sensors and transducers, amplifier signal conditioner, signal isolation, transmission, display, data acquisitionmodules, interfaces, recording. Control centre, instrumentation diagram.

Temperature measurement: Expansion thermometers - constant-volume gas thermometer, pressure spring thermometer, volumetric and pressure thermometers; Thermoelectric temperature measurement - Thermoelectricity, industrial thermocouples; Resistance thermometers -industrial resistance thermometers, null-bridge resistance thermometers, deflectional resistance thermometers; Radiation temperature measurement - radiation pyrometers, photoelectric pyrometers and opticalpyrometers.

Unit 2

Measurement of pressure and vacuum: Pressure, vacuum and head; liquid column manometers - U-tube type, well type and inclined type, micromanometers; Lowpressure measurement - kenetometer, McLeod gage, thermal conductivity gauge; Barometer method for atmospheric pressure measurement; pressure measurement using bourdon tube, flat and corrugated diaphragms, and capsules; Measurement of pressure in corrosive fluids using liquid seal and diaphragm seal. Hydrostatic type, Elastic Element type, Electrical Type and other type of instruments like Neleod Gauge, Thermocouple gauge, Knudson Gauge, Ionization Gauge.

Flow measurement: Variable area and variable head flow meters, volumetric and mass flow rate meters, linear velocity measurement systems, anemometers; Measurement of Head and Level: Density and specific gravity - constant volume hydrometer, air pressure balance method, gas density detector and gas specific gravity measuring system; Level measurement: pressure type, resistance & capacitance type, sonic & ultrasonic, thermal type level meters, level measurement in open vessels and in pressure vessels, solid level detectors.

Unit 3

Viscometers: Redwood, Saybolt, Engler, Cup and Cone type, Rheo & other types of viscometers; Composition analysis - Gas analysis by thermal conductivity, analysis ofmoisture in gases (humidity), psychrometer method, hygrometer method, dew-point method for moisture analysis in gases, measurement of moisture solids; pH measurement; Gas analysis by thermal conductivity, polarography & chromatography; Composition analysis using spectroscopic methods;On line instrumentation in modern plants.

TEXTBOOK:

1. *Jain R. K., Mechanical and Industrial Measurements, Khanna*

REFERENCES:

1. *Ernest O. Doebelin, "Measurements systems Application & design", McGraw Hill Publishing, 1990.*
2. *T. G. Beckwith, R. D. Marangoni and J. H. Lienhard, "Mechanical Measurements", 6th Edn, Prentice Hall, 2006.*
3. *Eckman D. P., Industrial Instrumentation, Wiley Eastern.*
4. *Patranabis, D., "Principles of Industrial Instrumentation" 2nd ed. Tata McGraw Hill, New Delhi.*

15CHE443 PROCESS INTENSIFICATION 3 0 0 3

Unit 1

Electrically Enhanced Processes; Microfluidics: Electrokinetics, Magnetohydrodynamics, Opto-microfluidics; Pressure-based Enhancement; Compact Heat Exchangers: Plate Heat Exchanger, Printed-Circuit Heat Exchanger, Spiral Heat Exchanger, Chart-Flo Heat Exchanger, Polymer-Film Heat Exchanger, Foam Heat Exchanger, Mesh Heat Exchanger; Micro-heat exchangers: Small Channels and Designs; Significance of dimensionless numbers.

Unit 2

Intensified Reactors: Spinning Disk Reactors; Oscillatory Baffled Reactors; Taylor-Couette Flow Reactor Microreactors: Basics & Applications; HEX Reactors; Induction Heating, Sonochemistry, Microwave Enhancement, Plasma Enhancement, Laser-Induced Reactions; Choice of reactors based on reaction type; Operating regimes of reactors - Dimensionless Analysis.

Supercritical Operation; Intensified Separation: Distillation Columns – Divided Wall Columns, Compact Heat Exchangers; HiGee; Centrifuges; Membrane-based Separation; Intensified Mixing: In-line Mixers: Static Mixer, Mixing on a Spinning Disk, Induction-Heated Mixer;

Unit 3

Reactive Separations: Reactive Distillation and Reactive Extraction; Membrane Reactors - Applications to dehydrogenation; Steam-methane reformation;

Case studies: Reaction separation of Plastic/Biomass pyrolysis; Petrochemicals and Fine Chemicals, Refineries, Bulk Chemicals, & Nuclear Industry.

TEXTBOOK / REFERENCES:

1. *David Reay, Colin Ramshaw, and Adam Harvey, "Process Intensification: Engineering for Efficiency, Sustainability and Flexibility" Butterworth-Heinemann, 2008*
2. *Frerich J. Keil, "Modeling of Process Intensification", Wiley-VCH, 2007*
Relevant journal publications

15CHE444 SAFETY AND HAZARD MANAGEMENT IN CHEMICAL INDUSTRIES 3 0 0 3

Unit 1

Hazard identification: General hazards of plant operation toxic hazards, fire and explosions – hazards. Transport of chemicals with safety unforeseen deviations, emergency management, planning for safety, selecting a basics of safety – preventive and protective measures, safety based on emergency, relief systems, safety based on containment operational safety procedural instructions – routine checks, process and product changes, safety checks, checklist for safety, leaks and detection.

Unit 2

Hazards of plant operation: Toxic hazards, fire and explosion hazards, reaction hazards, literature calculations & explosions screening, normal reaction, gas evolution, characterizing runaway, control and mitigation of gas emanations, absorption with chemical reaction, health and environmental effects. Special problem of developing countries, safety gadgets, dispersions, degree of hazards, disposals, hierarchy of options, threshold limits, laws of safety, accident reporting.

Unit 3

Storage, central handling safety, unintentional spills, runoff emits, containment economics, waste disposal and environmental protection, incineration, alternatives. Risk analysis, evaluation, mitigation, Hazop, Hazan, definition, probability quantification – risk, engineering, clean technology, initiatives, standards, emergency handling, accident investigation, legislation, nil-risk quantification methods. Case histories of accidents, examples of hazards assessment, examples of use of Hazan, explosion hazards in batch units, technical process, documentation for hazardous chemicals, format and methods.

TEXTBOOKS:

1. *A. K. Rohatgi, "Safety handling of Hazardous Chemicals", J. K. Enterprises, Mumbai, 1986.*
2. *S. K. Shukla, "Enviro Hazards and Techno Legal Aspects", Shashi Publications, Jaipur, 1993.*
3. *G. L. Wells and R. M. C. Seagrave, "Flow sheeting for safety", Institution of Chemical Engineering, London, 1977.*

REFERENCES:

1. *T. Kletz, "Learning from Accidents", 3rd Edition, Gulf Professional Publishing, London, 1988.*
2. *J. Barton and R. Rogers, "Chemical Reaction Hazards – A Guide to Safety", Institution of Chemical Engineering, Gulf Professional Publishing, London, 1997.*

15CHE445 SOLAR ENERGY 3 0 0 3

Unit 1

Solar energy

Solar radiation, its measurements and analysis. Solar angles, day length, angle of incidence on tilted surface, Sunpath diagrams, Shadow determination. Extraterrestrial characteristics, Effect of earth atmosphere, measurement & estimation on horizontal and tilted surfaces.

Solar cell physics

p-n junction, homo and hetro junctions, Metal-semiconductor interface, Dark and illumination characteristics, Figure of merits of solar cell, Efficiency limits, Variation of efficiency with band-gap and temperature, efficiency measurements, high efficiency cells, Tandem structure.

Unit 2

Solar cell fabrication technology

Preparation of metallurgical, Electronic and Solar grade Silicon, Production of Single Crystal 'Si', Chocharlski (CZ) and Float Zone (FZ) method for preparation of silicon, procedure of masking, photolithography and etching, Design of a complete silicon, GaAs, InP solar cell. High efficiency III-V, II-VI multijunction solar cell, a-Si-H based solar cells, Quantum well solar cell, Thermophotovoltaics. Nanosolar cells. Thin film technologies.

Solar Cell Characterization

Characterization of solar cells: IV characteristics, impedance, incident photon-to-current conversion efficiency (IPCE), intensity modulated photovoltage spectroscopy (IMPV), lifetime measurements.

Solar photovoltaic system design

Solar cell arrays, system analysis and performance prediction, shadow analysis, reliability, solar cell array design concepts, PV system design, Design process and optimization, Detailed array design, storage autonomy, Voltage regulation, maximum tracking, Power electronic converters for interfacing with load and grid, use of computers in array design, Quick sizing method, Array protection and troubleshooting.

Unit 3

Emerging Photovoltaic Technologies

Working principle, characterization and applications of: organic solar cells, dye sensitized solar cells, quantum dot solar cells, bulk heterojunction solar cells

SPV applications

Centralized and decentralized SPV systems, stand alone, hybrid and grid connected systems, system installation, operation and maintenances, case studies and field experience, PV market analysis and Economics of SPV systems.

TEXTBOOKS:

1. *John W Twidell and A D Weir, Renewable Energy Resources, ELBS*
2. *T Bhattacharya, Terrestrial Solar Photovoltaic, Narosa Publishers Ltd, New Delhi*

REFERENCE BOOKS:

1. *Garg H P., Prakash J., Solar Energy: Fundamentals & Applications, Tata McGraw Hill, New Delhi, 1997*
2. *S P Sukhatme, Solar Energy, Tata McGraw Hill*
3. *J F Kreider and Frank Kreith, Solar Energy Handbook, McGraw Hill*
4. *D Y Goswami, Frank Kreith and J F Kreider, Principles of Solar Engineering, Taylor & Francis.*

15CHE470 FUNDAMENTALS OF MANAGEMENT 3 0 0 3

Unit 1

Introduction - Managers and Management. The historical roots of contemporary management practices - the pre-modern era, classical contributions, human resources approach, the quantitative approach. The Management Environment - A global market place, emphasis on technology, society and managers, entrepreneurship.

Foundations of Planning - Planning in uncertain environments, types of plans, management by objectives. The importance of organizational strategy, strategic framework, quality as a Strategic weapon. Foundations of Decision Making - The decision-making process, making decisions - the rational model, modifications of the rational model. Decision making - a contingency approach, decision-making styles, making decisions in groups.

Unit 2

Basic Organization Designs - The elements of structure, contingency variables affecting structure, organization design applications, learning organization, organization culture.

Managers and the Human resource management process - Employment planning, recruitment and selection, orientation, training, and development, performance

management, compensation and benefits, managing change, stress and innovation, change process, organizational change and member resistance, making changes in the organization. Stress - the aftermath of organizational change, stimulating innovation.

Unit 3

Foundations of Individual and Group behaviour - Explaining and predicting behaviour, personality, perception, learning, foundations of group behaviour. Understanding work teams - types of work teams, characteristics of high-performance work teams. Motivating and rewarding employees - motivation and individual needs, early theories of motivation, contemporary theories of motivation. Leadership and Trust - Managers versus leaders, trait theories of leadership, behavioral theories of leadership, contingency theories of leadership, emerging approaches to leadership, contemporary leadership issues, building trust. Communication and Interpersonal skills - understanding communication, communication and Information Technology, developing interpersonal skills.

Foundations of Control - the importance of control, types of control, control implications for managers, the dysfunctional side of control.

TEXTBOOK:

Stephen P. Robbins, David A. DeCenzo, Sanghamitra Bhattacharya, Madhushree Nanda Agarwal. "Fundamentals of Management" – Pearson Prentice Hall, Sixth Edition

15CHE471 MANAGERIAL ECONOMICS AND ACCOUNTING 3 0 0 3

Unit 1

Introduction to Economics and managerial Decision Making, the Economics of a business, a brief review of important economic terms and concepts; Supply and Demand - market demand, market supply, determinants of supply and demand, short run market changes and long run market analysis, comparative statics analysis, Demand Elasticity - the economic concept of elasticity, the price elasticity of demand, the cross-elasticity of demand, income elasticity, other elasticity measures, elasticity and total revenue; Elasticity of Supply. Applications of elasticity. Marginal utility, the law of diminishing marginal utility.

The theory and estimation of production - the production function, a short-run analysis of total, average, and marginal product, the three stages of production in the short run, long run and the law of diminishing returns, derived demand and the optimal level of variable input usage. Forms of production function.

Unit 2

The Theory and Estimation of Cost - the importance of Cost in managerial decisions,

the relationship between production and cost, the short-run cost function, the long-run cost function, economies of scale.

Pricing and output decisions - Competition and market types, pricing and output decisions in perfect competition, selecting optimum output level, competitive market in the long run; Pricing and output decisions in monopoly markets, implications for managerial decision making. Pricing and output decisions in monopolistic competition; oligopoly and market concentration, pricing in oligopolistic market.

Unit 3

Management accounting: Balance Sheet and Profit and Loss account – financial statements, assets, liabilities, and owner's equity, relationship between assets, liabilities and owner's equity, forms of the balance sheet, profit and loss account, relation between balance sheet and profit and loss account. Cost classifications and allocation - nature of cost, historical and future costs, cost classifications in a manufacturing firm, cost concepts for planning and control, cost allocation; cost-volume-profit analysis and operating leverage; Break-even analysis, break-even point, operative leverage.

Capital expenditure planning - nature of investment decisions, investment evaluation criteria, time value of money, net present value method, internal rate of return method, profitability index, payback period, accounting rate of return method, cash flows for investment analysis. Capital budgeting process.

Paul G. Keat, Philip K. Y. Young, Sreejata Banerjee "Managerial Economics" Economic Tools for Today's Decision Makers – Sixth Edition.
I M Pandey, "Management Accounting", A Planning and Control Approach, Vikas Publishing House Pvt Ltd.,

15CHE472 PROJECT ENGINEERING OF PROCESS PLANTS 3 0 0 3

Unit 1

Scope of project engineering - the role of project engineer - R & D - TEFR - plant location and site selection - preliminary data for construction projects - process engineering – flowdiagrams - plot plans - engineering design and drafting. Planning and scheduling of projects - bar chart and network techniques.

Unit 2

Business and legal procedures: Procurement operations, Organization and operation of procurement department, Procurement procedure, General purchaser-vendor practices, contracts and contractors, project financing, statutory sanctions.

Details of engineering design and equipment selection - design calculations excluded -Vessels, heat exchangers, process pumps, compressors and vacuum pumps, motors and Turbines, other process equipment

Unit 3

Details of engineering design and equipment selection II - design calculations excluded - piping design, thermal insulation and buildings, safety in plant design, plant constructions,start up and commissioning.

Critical path method (CPM) and Programme evaluation and review technique (PERT) in project engineering.

REFERENCE BOOKS

1. *Peter Watermeyer , Handbook for Process Plant Project Engineers, Wiley, 2002*
2. *Howard F. Rase, M. H. Barrow, Project engineering of process plants, Wiley, 1957*
3. *Peter S. Max &Timmerhaus, Plant design and economics for chemical engineers, Mc Graw Hill, 2002.*
4. *B. C. Punmia & K. K. Khandelwal, Project Planning and Control with PERT & CPM, Firewall Media, 2002*
5. *Srinath L. S., PERT AND CPM, 3rd Edn Affiliated East Press Pvt. Ltd., New York, 2001.*
6. *Perry J. H,"Chemical engineering handbook" 7th ed. McGraw Hill, 1997.*
7. *Ernest E. Ludwig, Applied project engineering and management, Gulf Pub. Co, 1988.*
8. *R K Sinnott, Chemical Engineering Design: Chemical Engineering Design, Chemical Engineering Technical Series, Elsevier, 2014.*

15CHE481 CHEMICAL PROCESS CONTOL LAB. 0 0 2 1

Calibration of temperature, pressure and flow measuring instruments, Dynamics of first order, second order, interacting and non-interacting systems, Control valve characteristics, Study of control systems involving temperature, pressure, flow and level, Study advanced control strategies and Controller tuning.

15CHE482 COMPUTER AIDED DESIGN OF CHEMICAL PROCESS LAB. 1 0 2 2

Introduction to Aspen PLUS/ HYSYS; Thermodynamic property methods; Solution strategies; Simulation of pressure changing devices (Pumps, Compressors and Turbine); Simulation of two-phase and three phase separation units, Simulation of heat exchangers, Simulation of reactors (Plug Flow, Mixed Flow, Conversion, Gibbs, Equilibrium reactors and their combinations); Simulation of Distillation, Absorption and Extraction columns;

Case study set up and Sensitivity analysis.

15CHE495 PROJECT PHASE I 2 cr

Identification of the problem based on the current need gaps of the industry / knowledge / other academic / theoretical aspects; literature survey, identification of the project deliverables, identification of materials / equipment requirements, preparation of the methodology for the experimentation, and procurement of the materials. Presentation of project progress report to the department for evaluation at the end of the semester.

15CHE499 PROJECT PHASE II 10 cr

Setting up of the experimental work (hardware/software), carrying out the experimental work, carrying out material characterization if required, analysis of the results, discussion and interpretation of the results, validation of the hypothesis, and reporting project outcome in the approvedformat.

Presentation of the work / findings to the faculty for review and feedback three times during the semester. The final project will be evaluated by expert panel consisting of internal and external examiners.

15CHY100 CHEMISTRY 3 0 0 3

Unit 1

Chemical Bonding

Review of orbital concept and electronic configuration, electrovalency and ionic bond formation, ionic compounds and their properties, lattice energy, solvation enthalpy and solubility of ionic compounds, covalent bond, covalency, orbital theory of covalency - sigma and pi bonds - formation of covalent compounds and their properties. Hybridization and geometry of covalent molecules - VSEPR theory - polar and non-polar covalent bonds, polarization of covalent bond - polarizing power, polarisability of ions and Fajan's rule, dipole moment, percentage ionic character from dipole moment, dipole moment and structure of molecules - co-ordinate covalent compounds and their characteristics, molecular orbital theory for H2, N2, O2 and CO, metallic bond - free electron, valence bond and band theories, weak chemical bonds – inter and intra molecular hydrogen bond - van der Waals forces.

Unit 2

Thermodynamic Parameters

Stoichiometry - mole concept, significance of balanced chemical equation - simple calculations - Conditions for occurrence of chemical reactions - enthalpy, entropy and free changes - spontaneity – Thermochemistry - heats of reactions - (formation, combustion, neutralization) - specific heats - variation of enthalpy change with

temperature - Kirchhoff' relation (integrated form) - bond enthalpy and bond order - Problems based on the above.

Kinetics

Review of molecularity and order of a reaction, rate law expression and rate constant - first, second, third and zero order reactions, pseudo-first order reactions (pseudo-unimolecular reactions) - complex reactions - equilibrium and steady state approximations - mechanism of these reactions - effect of temperature on reaction rates - Arrhenius equation and its significance, Michaelis Menden kinetics-enzyme catalysis.

Unit 3

Electrochemistry

Electrolytes - strong and weak, dilution law, Debye-Huckel theory, faraday's laws, origin of potential, single electrode potential, electrochemical series, electrochemical cells, Nernst equation and its application, reference electrodes - SHE, Ag/AgCl, Calomel.

Photochemistry

Photochemistry, laws of photochemistry - Stark-Einstein law, Beer-Lamberts law, quantum efficiency-determination, photochemical processes - Jablonsky diagram, internal conversion, inter-system crossing, fluorescence, phosphorescence, chemiluminescence and photo sensitization, photo polymerization.

REFERENCE BOOKS:

Physical chemistry, Puri and Sharma

Inorganic chemistry, Puri and Sharma

15CHY181 CHEMISTRY LAB. 0 0 2 1

1. Acid base titration (double titration)
2. Complexometric titration (double titration)
3. Redox (permanganimetry) titration (double titration)
4. Conductometric titration
5. Potentiometric titration
6. Ester hydrolysis

15CHY231 ADVANCED POLYMER CHEMISTRY 3 0 0 3

Unit 1

Newer Polymers and Polymerizations: Polymeric Liquid Crystals - Inorganic and Organometallic polymers - Synthesis and reactions of Phosphorus - Nitrogen polymers - Boron - Silicone polymers. Cyclisation versus Linear Polymerization -

Molecular weight control in linear polymerization - Molecular weight distribution in linear polymerization - Molecular weight distributions in nonlinear polymerization - Multichain Polymerization - Metallocene Polymerization.

Unit 2

Solid-state irradiation polymerization - Atom transfer radical polymerization - Plasma Polymerization - Zwitterionic Polymerization - Isomerization polymerization - Polymer supported solid phase reactions - Merrifield method.

Polymer degradation and stabilization: Mechanism of different types of degradation - Commonly used antidegradants and the mechanism of their stabilization.

Unit 3

Polymer solutions: Criteria for solubility - Heat of Dissolution and Solubility parameters - Conformation of polymer chains in solutions - Nature of polymer molecules in solution - Size and shape of macromolecules in solution - Thermodynamics of polymer solutions - Phase equilibria - Entropy and heats of mixing of polymer solutions - Effect of molecular weight on solubility - Solubility of crystalline and amorphous polymers - Flory Huggins theory of polymer solution, Equation of state theory, Flory Krigbaum theory and cluster type theory - Viscosity of dilute polymer solutions.

TEXTBOOKS:

1. *George Odian, "Principles of Polymerization", John Wiley & Sons Inc., New York, (1991).*
2. *Malcolm P.Stevens, "Polymer Chemistry", Oxford University Press, New York, (1999).*

REFERENCES:

1. *Harry R Allcock and Frederick W Lampe, "Contemporary Polymer Chemistry", 2nd edition, Prentice Hall, Inc., New Jersey, (1990).*
2. *Charles E Carraher, Jr., "Polymer Chemistry", 5th edition, Marcel Dekker Inc., New York, (2000).*
3. *Jayadev Sreedhar and Govariker, "Polymer Chemistry".*

15CHY232 BIOMATERIALS SCIENCE 3 0 0 3

Unit 1

Introduction: Bulk properties, Surface properties and characterization - polymers, silicone biomaterials, medical fibres and biotextiles - Smart polymers - bioresorbable and bioerodible materials - natural materials, metals and ceramics - physicochemical surface modification.

Biocompatibility concepts: Introduction to biocompatibility - cell material interaction – types of materials - toxic, inert, bioactive - long term effects of materials within the body - cell response.

Unit 2

Chemical and biochemical degradation of polymers - degradation of metals and ceramics - calcification of biomaterials.

Host reactions and their evaluation: Inflammation and foreign body response - adaptive immunity - systemic toxicity and hypersensitivity - blood coagulation and blood materials interactions - device related infections.

Unit 3

Biological testing of biomaterials: Invitro and invivo assessment of tissue compatibility - evaluation of blood materials interaction - microscopy in biomaterials.

Practical aspects of biomaterials: Bioelectrodes, biomedical sensors and biosensors - sterilization of implants - implant failure - implant retrieval and evaluation - legal aspects, ethical issues and regulation aspects.

TEXTBOOK:

Buddy D Ratner, Allan S Hoffman, "Biomaterials Science - An introduction to materials in Medicine", Elsevier academic press, (2004).

REFERENCES:

1. *Jonathan Black, "Biological Performance of Materials: Fundamentals of Biocompatibility", 4th edition, CRC Press, (2006).*
2. *John D. Enderle, Susan M. Blanchard, Joseph D. Bronzino, "Introduction to Biomedical Engineering", 2nd edition, Elsevier Academic Press, 2005.*

15CHY233 CATALYTIC CHEMISTRY 3 0 0 3

Unit 1

Catalysis: Introduction, Industrial applications. Rates of reactions - equilibrium, energy of activation and the catalyst's role, Elementary reactions in catalytic transformations homogeneous and heterogeneous catalysis.

Catalysis in solutions: Acid-base catalysis - catalysis in the gas phase, catalysis in dilute aqueous solution, catalysis in concentrated strong acid solutions, catalysis by bases, catalysis by metal ions, catalysis by electron transfer, organometallic catalysis, catalysis in Ziegler Natta / Metallocene / Metathesis polymerization.

Unit 2

Catalysis by macromolecules, Phase transfer catalysis.

Catalysis by Enzymes: Introduction - kinetics of enzyme catalyzed reaction, catalysis through enzyme, organic catalysis, metalloenzyme catalysis, supported enzymes. Industrial applications of enzyme catalyst.

Catalysis by Polymers: Attachment of catalytic groups to polymer supports, Adsorption and the Kinetics of polymer-catalyzed reactions.

Unit 3

Catalysis in polymer gels, bifunctional and multifunctional catalysis, porous polymers, Applications of polymer catalysis.

Catalysis in Molecular scale cavities: Structures of crystalline solids, structure of Zeolites, catalysis by Zeolites, catalysis by Zeolites containing metal complexes and clusters. Catalysis on surfaces – surface catalysis, catalysis on metal surfaces.

TEXTBOOKS:

1. *Bruce C Gates, "Catalytic Chemistry", John Wiley & Sons, Inc. USA, (1992).*
2. *Viswanathan B, Sivasankar S, Ramaswamy A V, "Catalysis, Principles and Applications", CRC Press, (2006).*

REFERENCES:

1. *James E House, "Principles of Chemical Kinetics", Academic Press, (2007).*
2. *Kuriacose J C, "Catalysis", Macmillan India Limited, New Delhi, (1991).*

15CHY234 CHEMISTRY OF ADVANCED MATERIALS 3 0 0 3

Unit 1

Chemistry of Engineering Plastics: Preparation, properties and applications of ABS, polycarbonates, epoxy resins - polyamides - Nylon and Kevlar.

Chemistry of Carbon nanotubes: Introduction, carbon nanotubes - fabrication, structure, electrical properties – vibrational properties – mechanical properties – applications of carbon nanotubes.

Unit 2

Electron transfer studies in salt based conductors and magnets: Introduction - definitions and units - ferromagnets and ferrimagnets. One-dimensional conductors - quasi one and two-dimensional super conductor. Fullerides - paramagnetic conductors and superconductors. Electron transfer salt based ferromagnets: nitroxide, metallocene and ferric magnet-based ferromagnets - weak ferro magnets. Nanopore containment of magnetic particles - nanocarbon ferromagnets.

Unit 3

Functional electro active polymers: Conjugated polymers - synthesis, processing and doping of conjugated polymers: polyacetylene, polyaniline, polythiophene, poly (p-phenylenevinylene) - ionically conducting polymers - applications of conjugated

polymers. Semi-conducting, poly ferrocene - photo resist optical fibers and sensors, photo chromic & thermo chromic materials.

Photochemistry in Electronics: Laws of absorption - quantum efficiency and quantum yield - florescence and phosphorescence – photosensitization.

High energy materials: Preparation, properties and application of ammonium nitrate (AN), NH4NO3, ammonium perchlorate (AP), NH4ClO4, ammonium dinitramide (AND), NH4N(NO2)2, hydrazinium nitroformate (HNF), N2H5C(NO2)3 etc.

TEXTBOOKS:

1. *Van Vlack, Lawrence H, "Elements of Material Science and Engineering", 6th edition, New York Addison, Wesley, (1989).*
2. *Chawla S, "A Textbook of Engineering Chemistry", Dhanpat Rai & Co, Delhi, (2001).*

REFERENCES:

1. *Mark Ratner and Daniel Ratner, 'Nano technology - A gently introduction to the next big idea', Pearson Education, (2003).*
2. *Interrante L. V. and Hampden Smith M.J, 'Chemistry of Advanced Materials', Wiley-VCH, (1988).*

15CHY235 CHEMISTRY OF ENGINEERING MATERIALS 3 0 0 3

Unit 1

Chemical materials in Electronics and Electrical Engineering: Structural correlation to behavior of conducting polymers, Semi-conducting polymers - properties of organic polymers containing metal groups such as poly ferrocene - optical fibers - definition, principle and structure - characteristics of optical fibre - photo resist optical fibre - advantages of optical fibre - liquid crystalline - peizo and pyroelectric polymers - magnetic materials, hard and soft magnets – sensors (voltametric).

Nanomaterials: Nanotubes and Nanowires, Carbon nanotubes, single walled and multiwalled, aligned carbon nanotubes, doping with boron – applications - Nanostructured polymers.

Unit 2

Chemical aspects in biotechnology - Enzymes and bio reactors - Biotechnological processes – Bio-sensors - glucose biosensors, bio-filters and bio-membranes – Bio-fertilizers, Bio-surfactants.

Chemistry of Engineering Plastics: Preparation, properties and applications of ABS, Polycarbonates, Epoxy resins - Polyamides - Nylon and Kevlar.

Photochemistry in Electronics: Photochemical reactions - laws of absorption (Grothers-Draper law - Stark-Einstein's law) - Quantum efficiency - photochemical decomposition of HI and HBr - and Quantum yield.

Unit 3

Florescence and Phosphorescence - chemiluminescence - photo sensitization.

Chemistry of Toxic Materials and Toxicology: Principles of Toxicology - Volatile poisons - Gases CO, hydrocyanic acid - H2S - PH3 - CO2 - SOx - NOx - Heavy metals - lead, arsenic, mercury, antimony, barium, bismuth, selenium, zinc, thallium - Pesticides - Food poisoning - Drug poisoning - barbiturates - narcotics - ergot - LSD - alkaloids - Radioactive Toxicology - Radiation hazards.

TEXTBOOK:

Kuriacose J C, Rajaram, "Chemistry in Engineering and Technology, Systematic Organic and Inorganic Chemistry and Chemistry of Materials (Vol 1 & 2)", Tata McGraw-Hill Publishing Company Limited, 1999.

REFERENCE:

Van Vlack, Lawrence H, "Elements of Material Science and Engineering" (6th edition), New York Addison-Wesley, 1989.

15CHY236 CHEMISTRY OF NANOMATERIALS 3 0 0 3

Unit 1

Introduction: Introduction to Nanomaterials: Size dependence of properties - Surface to volume ratio and Quantum confinement. Microscopic techniques to study nano structures - SEM, AFM - TEM and STM - Raman spectroscopy.

Synthesis of Nanomaterials: Synthetic approaches: Colloidal Self-Assembly (Self-assembled monolayers - SAMs) and electrostatic self-assembly, electrochemical methods, sol-gel deposition.

Unit 2

Langmuir-Blodgett (LB) technique, chemical vapour deposition, plasma arcing and ball milling.

Carbon nanostructures: Carbon Clusters: Fullerenes, structure, synthesis, alkali doped C60 - superconductivity in C60, applications of fullerenes. Carbon nanotubes: Classification, properties, synthesis, characterization, and potential applications, growth mechanism of carbon nanotubes.

Other Nanostructures: Quantum Dots: Preparation, properties and applications of Au, CdS and CdSe quantum dots,

Unit 3

Fabrication and applications of conducting polymer nanotubes, TiO2 and metallic nanotubes.

Molecular Electronics and Machines: Molecular electronics: Working of Molecular and supramolecular switches, transistors and wires. Molecular machines: Working of Molecular motors, rotors, cars, elevators and valves.

TEXTBOOKS:

1. *Charles P Poole Jr, Frank J Ovens, "Introduction to Nanotechnology", Wiley Interscience, (2003).*
2. *Alexei Nabok, "Organic and Inorganic Nanostructure", Artech House, Inc. (2005).*
3. *Peter J F Harris, "Carbon Nanotube Science: Synthesis, Properties and Applications", Cambridge University Press, (2009).*
4. *Balzani V, Credi A, Venturi M, "Molecular devices and machines - A journey in to the Nanoworld", Wiley VCH, (2003).*

REFERENCES:

1. *Rao C N R, Muller A, Cheetham A K (Eds.), "The Chemistry of Nanomaterials: Synthesis, Properties and Applications", WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, (2004).*
2. *Zhong Lin Wang, "Characterization of nanophase materials", Wiley VCH, (2000).*
3. *Massimiliano Di Ventra, Stephane Evoy, James R Heflin, "Introduction to nanoscale science and technology", Kluwer Academic Publishers, (2004).*
4. *William A Goddard, III, Donald W Brenner, Sergey Edward Lyshevski and Gerald J. Lafrate, "Handbook of Nanoscience, Engineering, and Technology", CRC Press, (2003).*
5. *Balzani V, Credi A, Venturi M, "Molecular devices and machines- A journey in to the Nanoworld" Wiley VCH (2003).*
6. *Bharat Bhushan, "Hand book of Nanotechnology", Springer, (2004).*

15CHY237 CHEMISTRY OF TOXICOLOGY 3 0 0 3

Unit 1

Introduction to Toxicology: Definition - scope - history - relationship to other sciences - dose-response relationship - sources of toxic compounds - Classes of Toxicants - broad overview of toxicant classes such as metals, agricultural chemicals, food additives - contaminants, toxins, solvents, drugs, and cosmetics - history, exposure route, and toxicity of the non-essential metals - cadmium, lead, and mercury - medical treatment of metal poisoning - classes of agricultural chemicals - Toxins - source, including microbial, fungal, algal, plant and animal - examples - Brief discussions - food additives and contaminants – solvents - therapeutic drugs - drugs of abuse - combustion products - cosmetics.

Unit 2

Exposure Classes, Toxicants in Air, Water, Soil, Domestic and Settings: Occupational Air, water and soil as primary media for human exposure to various classes of

chemical toxicants in environmental, domestic, and occupational settings - historic and present status of air pollution and air quality - introduction to the major classes of soil and water pollutants - sources, exposure routes and potential adverse health effects - Classes of occupational toxicants - route of exposure and permissible levels - specific examples of concern.

Unit 3

Toxicant Analysis and Quality Assurance Principles: Introduction to procedures, principles and operation of analytical laboratories in toxicology. Summary of the general policies - analytical laboratory operation, analytical measurement systems, quality assurance (QA) - quality control (QC) procedures.

Environmental Risk Assessment: Environmental risk assessment procedures - particular environmental risk problem - appropriate endpoints - development of conceptual models, analyzing exposure – effects, information - characterizing exposure - ecological effects - management of risks.

Future Considerations for Environmental and Human Health: Changes in toxicology - evaluation of future risk assessment - more fundamental aspects of toxicology - in vivo and in vitro toxicity - biochemical toxicology - molecular toxicology - development of selective toxicants.

TEXTBOOK:

Ernest Hodgson, "Modern Toxicology", John Wiley & Sons, Inc., (2004).

REFERENCES:

1. *John Wright, "Environmental Chemistry", Routledge, (2003).*
2. *A K De, "Environmental Chemistry", New Age International, (2003).*
3. *Fritz Helmet, "Environmental Chemistry", Sarup and sons (Delhi), (2003).*

15CHY238 COLLOIDAL AND INTERFACIAL CHEMISTRY 3 0 0 3

Unit 1

Introduction to surfaces, interfaces and colloids: Molecular origin, Surface phenomena and structure of interfaces, Surfactants structure, colloids in action - shapes and size distribution, Types of interaction forces - Physical and Chemical interaction, Classification of physical forces - Vander Waals force, electrostatic forces.

The Adsorption Phenomena - Structure and Properties of Adsorption Layers at the Liquid-Gas Interface, Principles of adsorption thermodynamics, The Gibbs equation, Structure and properties of the adsorption layers at the air-water interface.

Unit 2

Interfaces between Condensed Phases - Wetting, The interfaces between condensed phases in two-component systems, Adsorption at interfaces between condensed phases.

Thermodynamics - Adsorption, energy consideration of physical adsorption vs chemisorptions, Gibbs adsorption equation, Langmuir isotherm, BET isotherm, adsorption at solid-liquid interfaces. Emulsions - formation and stability, HLB number, PIT (Phase Inversion Temperature) foams, aerosols, Microemulsions, vesicles, micelles and membranes - applications of various colloidal systems.

Unit 3

Characterization of Colloids, Rheological properties - Classification, Interfacial rheology, Interfacial tension, Electrochemistry of interfaces - Electric double layer.

Stability of charge stabilized colloids, DLVO theory, Hamaker constant, Boltzmann distribution, Debye length, specific ion adsorption, stern layer, electrostatic, steric and electrosteric stabilization, zeta potential, surface tension, wetting and spreading, contact angle - Young's modulus, practical application- solid surfaces- surface mobility, characteristics and formation.

TEXTBOOKS:

1. *D. Myers, "Surfaces, Interfaces and Colloids: Principles and Applications", 2nd Edition, Wiley-VCH, 1999.*
2. *T. Cosgrove, "Colloid Science: Principles, Methods and Applications", 2nd Edition, Wiley-Blackwell, 2010.*

REFERENCES:

1. *P. C. Hiemenz and R. Rajagopalan (Editors), "Principles of Colloid and Surface Chemistry", 3rd Edition, Academic Press, New York, 1997.*
2. *J. W. Goodwin, "Colloids andInterfaces with Surfactants and Polymers", John-Wiley and Sons Ltd, 2004*
3. *William Harde, "Colloids and Interfaces in Life Sciences", Marshell Dekker Inc. 2003*

15CHY239 COMPUTATIONAL CHEMISTRY AND MOLECULAR MODELLING 3 0 0 3

Unit 1

Introduction: Stability, symmetry, homogeneity and quantization as the requirements of natural changes - Born - Haber cycle – Energetic – kinetics - Principles of spectra.

Computational techniques: Introduction to molecular descriptors, computational chemistry problems involving iterative methods, matrix algebra, Curve fitting.

Molecular mechanics: Basic theory - Harmonic oscillator – Parameterization - Energy equations - Principle of coupling - Matrix formalism for two masses - Hessian matrix - enthalpy of formation - enthalpy of reactions.

Introduction to Quantum mechanics - Schrodinger equation - Position and momentum - MO formation - Operators and the Hamiltonian operator - The quantum oscillator - Oscillator Eigen value problems - Quantum numbers - labeling of atomic electrons.

Unit 2

Molecular Symmetry: Elements of symmetry - Point groups - Determination of point groups of molecules.

Huckel's MO theory: Approximate and exact solution of Schrodinger equation - Expectation value of energy - Huckel's theory and the LCAO approximation - Homogeneous simultaneous equations - Secular matrix - Jacobi method - Eigen vectors: Matrix as operator - Huckel's coefficient matrix - Wheeland's method - Hoffmann's EHT method - Chemical applications such as bond length, bond energy, charge density, dipole moment, Resonance energy.

Unit 3

Self consistent fields: Elements of secular matrix - Variational calculations - Semi empirical methods - PPP self consistent field calculation - Slater determinants - Hartree equation - Fock equation – Roothaan - Hall equation - Semi empirical models and approximations.

Ab-initio calculations: Gaussian implementations – Gamess - Thermodynamic functions - Koopman's theorem - Isodesmic reactions, DFT for larger molecules - Computer aided assignments / mini projects with softwares - Introduction to HPC in Chemical calculations.

Molecular modelling software engineering - Modeling of molecules and processes - Signals and signal processing in Chemistry - QSAR studies and generation of molecular descriptors - Applications of chemical data mining - Familiarization with open source softwares useful for molecular modeling - Introduction to molecular simulation - M.D. simulation.

TEXTBOOKS:

1. *K. I. Ramachandran, G Deepa and K Namboori, "Computational Chemistry and Molecular Modeling - Principles and Applications", Springer-Verlag, Berlin, Heidelberg, 2008, ISBN-13 978-3-540-77302-3.*
2. *Donald W Rogers, "Computational Chemistry Using PC", Wiley, (2003).*
3. *Alan Hinchliffe, "Chemical Modeling from atoms to liquids", Wiley, (2005).*

REFERENCES:

1. *James B Forseman and Aeleen Frisch-Gaussian, "Exploring Chemistry with Electronic Structure Method", Inc., Pittsburgh, PA, 2nd edition, (2006).*
2. *A C Philips, "Introduction to Quantum mechanics", Wiley, (2003).*
3. *Wolfram Koch, Max C. Holthausen, "A Chemist's guide to Density Functional Theory", Wiley, VCH, 2nd edition, (2001).*

15CHY241 ELECTROCHEMICAL ENERGY SYSTEMS AND PROCESSES 3 0 0 3

Unit 1

Background Theory: Origin of potential - electrical double layer - reversible electrode potential - standard hydrogen electrode - emf series - measurement of potential - reference electrodes (calomel and silver/silver chloride) indicator and ion selective electrodes - Nernst equation - irreversible processes - kinetic treatment - Butler-Volmer equation - Overpotential, activation, concentration and IR overpotential - its practical significance - Tafel equation and Tafel plots - exchange current density and transfer coefficients.

Unit 2

Batteries: Primary batteries: The chemistry, fabrication and performance aspects, packing classification and rating of the following batteries: (The materials taken their function and significance, reactions with equations, their performance in terms of discharge, capacity, and energy density to be dealt with). Zinc-carbon (Leclanche type), zinc alkaline (Duracell), zinc/air, zinc-silver oxide batteries; lithium primary cells - liquid cathode, solid cathode and polymer electrolyte types and lithium-ferrous sulphide cells (comparative account).

Secondary batteries: ARM (alkaline rechargeable manganese) cells, Lead acid and VRLA (valve regulated (sealed) lead acid), nickel-cadmium, nickel-zinc, nickel-metal hydride batteries, lithium ion batteries, ultra thin lithium polymer cells (comparative account). Advanced Batteries for electric vehicles, requirements of the battery - sodium-beta and redox batteries.

Unit 3

Reserve batteries and Fuel cells: Reserve batteries - water activated, electrolyte activated and thermally activated batteries - remote activation - pyrotechnic materials. Fuel Cells: Principle, chemistry and functioning - carbon, hydrogen-oxygen, proton exchange membrane (PEM), direct methanol (DMFC), molten carbonate electrolyte (MCFC) fuel cells and outline of biochemical fuel cells.

Electrochemical Processes: Principle, process description, operating conditions, process sequence and applications of Electroforming – production of waveguide

and plated through hole (PTH) printed circuit boards by electrodeposition; Electroless plating of nickel, copper and gold; Electropolishing of metals; Anodizing of aluminium; Electrochemical machining of metals and alloys.

TEXTBOOKS:

1. *Derek Pletcher and Frank C. Walsh, "Industrial Electrochemistry", Blackie Academic and Professional, (1993).*
2. *Dell, Ronald M Rand, David A J, "Understanding Batteries", Royal Society of Chemistry, (2001).*

REFERENCES:

1. *Christopher M A, Brett, "Electrochemistry – Principles, Methods and Applications", Oxford University, (2004).*
2. *Watanabe T, "Nano-plating: microstructure control theory of plated film and data base of plated film microstructure", Elsevier, Oxford, UK (2004).*
3. *Kanani N, "Electroplating and electroless plating of copper and its alloy", ASM International, Metals Park, OH and Metal Finishing Publications, Stevenage, UK (2003).*
4. *Lindon David, "Handbook of Batteries", McGraw Hill, (2002).*
5. *Curtis, "Electroforming", London, (2004).*
6. *Rumyantsev E and Davydov A, "Electrochemical machining of metals", Mir, Moscow, (1989).*

15CHY242 ENVIRONMENTAL CHEMISTRY 3 0 0 3

Unit 1

Air and air pollution (earth's atmosphere): Regions - ozone - CFC and other chemicals - catalytic decomposition of ozone - 'ozone hole' formation - Air pollution due to gas emission from industries - Atmospheric aerosols – dust, combustion products, aerosol concentration and lifetimes - Automobile exhausts, smog and effects - Acid rain - chemistry of acid rain, roll of meteorology, greenhouse gases and global warming - air pollution due to jet engines.

Water and water pollution (hydrosphere): Physical and chemical properties of water - microbiological processes - carbon, nitrogen cycles - Water pollution - polluting agents - indices of pollution, heavy metal pollution and toxicity - BOD and COD determination - suspended solids - determination of other ions by photometric methods - Chemistry of anaerobic process, use of Effective Microorganisms.

Unit 2

Aerobic processes - wastewater treatment systems (brief description only) - anaerobic and aerobic - sewage treatment, primary, secondary and tertiary processes - water reuse and recycle. Eutrophication of lakes, nitrogen and phosphorus in effluents - Drinking water standards - sources - fluoride and arsenic in water, purification, sterilization - chemistry of chlorination - water purification for domestic use - reverse osmosis - nano filters and membranes.

Industrial Pollution and its control: Industrial pollution and waste waters from various types of industries - environmental pollution due to paper mills, textile mills etc., and its control. Solid waste disposal - methods - solid waste from mining and metal production and its disposal - Electrochemical treatment of pollution control, electro-coagulation and flocculation - Green chemical processes and green solvents - reaction conditions to control industrial pollution.

Unit 3

Other types of pollution: Soil pollution - agricultural pollution - use of chemical fertilizers - Organic chemicals and environment, dioxins and furans - chemistry of some of the pesticides, insecticides and herbicides, ill effects due to uncontrolled use - Bulk storage of hazardous chemicals and disasters, Radioactive pollution, radiation units, sources - exposure and damage - safety standards - radioactive wastes and their disposal - Toxicological substances, testing of toxic substance, enzyme inhibition and biochemical effects of toxic chemicals on humans.

Sampling and Measurements of Pollutants: Sampling and analysis techniques of air pollutants (brief outline only) - analysis of particulate matter and lead - Sampling and measurements of water pollutants - organic loadings, phosphates and nitrogen compounds - monitoring of water quality - water test kits, various analytical methods (brief outline only).

TEXTBOOKS:

1. *Gary W. Van Loon and Stephen J. Duffy, "Environmental Chemistry", Oxford University Press, (2000).*
2. *Ajay Kumar Bhagi and G. R. Chatwal, "Environmental Chemistry", Himalaya Publishing House, (2003).*

REFERENCES:

1. *John Wright, "Environmental Chemistry", Routledge, (2003).*
2. *A K De, "Environmental Chemistry", New Age International, (2003).*
3. *Fritz Helmet, "Environmental Chemistry", Sarup and sons (Delhi), (2003).*
4. *Clair N Sawyer, Perry L McCarty and Gene F Parkin, "Chemistry for Environmental Engineering", McGraw Hill, (1994).*
5. *Jack Barrett, "Chemistry in your Environment", Albion Publishing Ltd., (1994).*
6. *Thomas G Spiro and William M Stigliani, "Chemistry of the Environment", Prentice Hall, (2002).*
7. *Kudisia V P and Ritu, "Environmental Chemistry", Pragati Prakashan, Meerut, (2000).*

15CHY243 FUELS AND COMBUSTION 3 0 0 3

Unit 1

Fuels - Solid fuels - Classification, preparation, cleaning, analysis, ranking and properties - action of heat, oxidation, hydrogenation, carbonization, liquefaction and gasification.

Liquid fuels – Petroleum - origin, production, composition, classification, petroleum processing, properties, testing - flow test, smoke points, storage and handling.

Secondary liquid fuels - Gasoline, diesel, kerosene and lubricating oils. Liquid fuels - refining, cracking, fractional distillation, polymerization. Modified and synthetic liquid fuels. ASTM methods of testing the fuels.

Unit 2

Gaseous fuels - Types, natural gas, methane from coal mine, water gas, carrier gas, producer gas, flue gas, blast furnace gas, biomass gas, refinery gas, LPG - manufacture, cleaning, purification and analysis. Fuels for spark ignition engines, knocking and octane number, anti knock additives, fuels for compression, engines, octane number, fuels for jet engines and rockets.

Flue gas analysis by chromatography and sensor techniques.

Unit 3

Combustion: Stochiometry, thermodynamics. Nature and types of combustion processes - Mechanism - ignition temperature, explosion range, flash and fire points, calorific value, calorific intensity, theoretical flame temperature. Combustion calculations, theatrical air requirements, flue gas analysis. combustion kinetics – hydrogen - oxygen reaction and hydrocarbon - oxygen reactions.
Rocket propellants and Explosives - classification, brief methods of preparation, characteristics; storage and handling.

TEXTBOOK:

Fuels and Combustion, Samir Sarkar, Orient Longman Pvt. Ltd, 3rd edition, 2009.

REFERENCES:

1. *Fuels - Solids, liquids and gases - Their analysis and valuation, H. Joshua Philips, Biobliolife Publisher, 2008.*
2. *An introduction to combustion: Concept and applications - Stephen R Turns, Tata Mc. Graw Hill, 3rd edition, 2012.*
3. *Fundamentals of Combustion, D P Mishra, 1st edition, University Press, 2010*
4. *Engineering Chemistry - R. Mukhopadhyay and Sriparna Datta, Newage International Pvt. Ltd, 2007.*

15CHY244 GREEN CHEMISTRY AND TECHNOLOGY 3 0 0 3

Unit 1

Our environment and its protection, chemical pollution and environmental regulations, environmental chemistry, pollution prevention strategies, challenges to the sustainability of chemical industry, Pollution Prevention Act 1990, USA, Green Chemistry and its 12

principles, toxicity of chemicals, material safety data sheet (MSDS), concept of zero pollution technologies, atom economy, functional toxicity vs non-functional toxicity, alternative solvents, energy minimization, microwave and sonochemical reactions, renewable feed stock, carbon dioxide as a feed stock.

Unit 2

Greener strategies of the synthesis of ibuprofen synthesis, teriphthalic acid etc. phase behaviour and solvent attributes of supercritical CO2, use of supercritical carbon dioxide as a medium chemical industry, use of ionic liquids as a synthetic medium, gas expanded solvents, superheated water, etc. Synthesis of various chemicals from bio mass, polycarbonate synthesis and CO2 fixation, green plastics, green oxidations, etc.

Unit 3

Processes involving solid catalysts – zeolites, ion exchange resins, Nafion/silica nano composites and enhanced activity. Polymer supported reagents, green oxidations using TAML catalyst, membrane reactors. Green chemistry in material science, synthesis of porous polymers, green nanotechnology.

REFERENCES:

1. *Hand Book of Green Chemistry and Technology; by James Clarke and Duncan Macquarrie; Blakwell Publishing.*
2. *Anastas, P. T., Warner, J. C. Green Chemistry: Theory and Practice, Oxford University Press Inc., New York, 1998.*
3. *Matlack, A. S. Introduction to Green Chemistry Marcel Dekker: New York, NY, 2001.*

15CHY245 INSTRUMENTAL METHODS OF ANALYSIS 3 0 0 3

Unit 1

Error Analysis and Sampling: Accuracy - Precision - Classification of Errors - Minimization of errors - Standard deviation - Coefficient of variance - F-test - t-test - Significant figures. Sampling - Basis of sampling, Sampling and physical state - Safety measures of sampling.

Separation Techniques: Brief out line of column, paper and thin layer chromatography - Ion exchange methods - principle and application – HPLC.

Unit 2

Gas chromatography - principle and applications – gel chromatography.

Electroanalytical techniques: Potentiometry - Potentiometric titration - determination of equivalence point - acid base, complexometric, redox and precipitation titrations

- merits and demerits. Voltammetry - Cyclic voltammetry - basic principle and application - Polarography - introduction - theoretical principles - migration current - residual current - half wave potential - instrumentation - analytical applications.

Unit 3

Spectro-chemical techniques: UV-VIS spetrophotometry - principle - Beer's Law application - photometric titration - single and double beam spectrophotometer - instrumentation of IR - sample handling - IR applications - H - NMR - Instrumentation and applications - principle - instrumentation - applications of atomic absorption spectroscopy.

Thermal and Diffraction techniques: Principles and applications of DTG - DTA - DSC - X-ray - Electron Diffraction Studies - SEM, TEM.

TEXTBOOKS:

1. *Willard H W, Merritt J R, "Instrumental Methods of Analysis", 6th edition, Prentice Hall, (1986).*
2. *Skoog Douglas A, West Donald, "Fundamentals of Analytical Chemistry", 7th edition, New York Addison, Wesley, (2001).*

REFERENCES:

1. *"Vogel's Textbook of Quantitative Chemical Analysis", 5th edition, ELBS, (1989).*
2. *Kaur. H, "Instrumental Methods of Chemical Analysis", Goel Publisher, (2001).*

15CHY246 MEDICINAL ORGANIC CHEMISTRY 3 0 0 3

Unit 1

Medicinal Chemistry: Introduction, drugs - classification of drugs - mechanism of drug action. Drug-receptor complex nomenclature - agonist, antagonist.

Physicochemical properties in relation to biological action: solubility, partition coefficient, dissociation constant, hydrogen bonding, ionization, drug shape, surface activity, complexation, protein binding, molar refractivity, bioisosterism - Stereo chemical aspects of drug action-stereo isomerism-optical isomerism.

Unit 2

Enzymes and hormones: Enzymes - nomenclature, classification and characteristics of enzymes - mechanism of enzyme action, factors affecting enzyme action, cofactors and co-enzymes, enzyme inhibition, enzymes in organic synthesis. Hormones and vitamins - representative cases.

Medicinal agents from natural products: Natural products as therapeutic agents, medicinal plants, animal products as medicine, isolation methods of alkaloids, terpenes, anti-oxidants.

Unit 3

Medicinal agents: Medicinal agents belonging to steroids, polypeptides, modified nucleic acid bases, sulphonamide and sulpha drugs, antibiotics, antifungal, antiseptics and disinfectants, anaesthetics, antihypertensive drugs, analgesics, histamine and anti-histamine agents.

TEXTBOOKS:

1. *Rama Rao Nadendla, "Principles of Organic Medicinal Chemistry", 1st edition, New age internationals (P) limited, (2005).*
2. *Thomas Nogrady and Donald F. Weaver, "Medicinal chemistry: A Molecular and Biochemical Approach", 3rd edition, Oxford university press, (2005).*

REFERENCES:

1. *Wilson C O, Gisvold O and Deorge R F, "Text book of organic, medicinal and Pharmaceutical chemistry", 7thedition, J. B. Lippincott company, Philadelphia, (1977).*
2. *Burger A, "Medicinal Chemistry", 3rdedition, Wiley Interscience, Newyork, (1970).*
3. *Graham L P, "An Introduction to Medicinal Chemistry", 3rd edition, Oxford university Press, (2005).*

15CHY247 MODERN POLYMER COMPOSITES 3 0 0 3

Unit 1

General introduction to composite materials: Concept and definition, classification of composites (CMC, MMC, PMC). Functional roles of reinforcement and matrix and importance of interface. Polymer matrix composites (PMCs): Fiber reinforced and particulate filled polymer composites. Reinforcements (glass, carbon / graphite, Kevlar), Matrices - Thermoset matrices - polyesters, epoxides, phenolics, vinyl esters, polyimides, cyanate esters - Thermoplastic matrices. Choice of reinforcements and matrices for different application needs.

Unit 2

Fiber reinforced polymer composites (FRPs): Basic rule of mixtures, stress-strain relationships. Tailoring of structural properties through laminar-sequencing and choice of fiber fractions / fiber orientations, to meet design requirements. Mechanical behavior of FRP composites: Fiber controlled and matrix dependent properties. Fibre volume fraction, tensile, shear, compressive, flexural, thermo elastic and off – axis responses of lamina and laminates - notched strength – fracture toughness - nondestructive testing. Effect of environmental conditions on properties.

Unit 3

Composite precursors: SMCs, DMCs, BMCs prepreg materials and their choice in specific applications. Fabrication processes for FRP Composites: hand layup, spray up, vacuum bag moulding, compression moulding, filament winding, braiding,

pultrusion, RTM, RIM, RRIM, RFI, autoclave moulding, injection moulding etc. Room temperature and hot curing of composites, Nanocomposites: Introduction; Nanoscale Fillers – Clay, POSS, CNT, nanoparticle fillers; Processing into nanocomposites; Modification of interfaces; Properties. Applications. Joining composite elements and repairs, Recycling of polymer composites.

TEXTBOOKS:

1. *B. Astrom, "Manufacturing of Polymer Composites", CRC Press, 1997.*
2. *P K Mallick, "Fiber-Reinforced Composites: Materials, Manufacturing,and Design", CRC Press, 2007.*

REFERENCES

1. *F. C. Campbell (Ed), Manufacturing processes for advanced composites, Elsevier, 2004.*
2. *S T Peters (Ed.), "Handbook of Composites", Springer, 1998.*

15CHY248 ORGANIC REACTION MECHANISMS 3 0 0 3

Unit 1

Introduction to organic chemistry: Lewis structure and formal charges of organic compounds - electro negativities and dipoles, resonances, aromaticity and anti aromaticity - equilibrium, tautomerism and hyper conjugation - acidity and basicity - pKa, nucleophiles and electrophiles - hydrogen bonding - different types of organic reaction - addition, substitution, elimination and rearrangement - oxidations and reductions - general principles of writing organic reaction mechanism - reactive intermediates.

Reaction of nucleophiles and bases: Nucleophilic substitution - SN1 and SN2 reactions, nucleophilic substitution at aliphatic sp2 carbon and aromatic carbon - nucleophilic addition to carbonyl compounds - addition of grignard and organo lithium reagents - reactions of nitrogen containing nucleophiles with aldehyde and ketones - aldol condensation.

Unit 2

Michael and 1,4-addition reaction - Favorskii rearrangement - benzilic acid rearrangement - reaction mechanism in basic media - Mannich reaction - enols and enolates.

Reaction involving acids and other eletrophiles: Carbocations - formation and rearrangements - cationic rearrangement involving electron deficient nitrogen atom - Beckmann rearrangement - Curtius, Lossen and Schmidt rearrangement - electrophilic additions - acid catalyzed reaction of carbonyl compounds - hydrolysis of carbocyclic acid derivatives - electrophilic aromatic substitution - carbenes and benzynes - Baeyer-Villeger reactions - Dienone-phenol rearrangement - pinacol rearrangement.

Unit 3

Radical and radical ions: Formation of radicals, radical chain processes, radical addition, reaction with and without cyclisation - fragmentation reaction - rearrangement of radicals - SRN 1 reaction - radical ions - Birch reduction - Hofmann-Loffler-Freytag reaction - Barton reaction - McMurry reaction.

Pericyclic reaction: Representative of molecular orbitals of ethylene, butadiene and hexatriene molecules - Woodward - Hofmann rules of symmetry - electrocyclic reaction, cycloadditions - diels-Alder reaction - other thermal cycloadditions - photochemical [2+2] cycloaddition - 1,3-dipolar cycloadditions - Sigmatropic reactions, notations and directions of [3,3] sigmatropic rearrangements - Cope and oxy-Cope rearrangement [2,3] sigmatropic reaction - ene reaction.

TEXTBOOK:

Jerry March, "Advanced Organic Chemistry", 4th edition, John Wiley & Sons, (1992).

REFERENCES:

1. *Carey F and Sundberg R, "Advanced Organic Chemistry - Part A & B", Kluwer, (2000).*
2. *Peter Sykes, "Organic reaction mechanism", 6th edition, Pearson education (Singapore) Pte. Ltd., (2005).*
3. *Michael B. Smith, "Organic Synthesis", 2nd edition, McGraw Hill, (2004).*

15CHY249 ORGANIC SYNTHESIS AND STEREOCHEMISTRY 3 0 0 3

Unit 1

Nomenclature of Organic compounds: Polyenes, Alkynes with and without functional groups by IUPAC nomenclature. Aromatic and Heteroaromatic systems - nomenclature of heterocycles having not more than two hetero atoms such as oxygen, sulphur, nitrogen.

Stereochemistry: Tacticity, R/S system of nomenclature of central and axial molecules.

Unit 2

Atropisomerism - isomerism of biphenyls - allenes and spiranes - ansa compounds - Geometrical isomerism, E, Z Isomerism. Asymmetric synthesis.

Conformational Analysis: Optical activity and chirality - Conformational Analysis of cyclic and acyclic system - Conformational effects on reactivity of acyclic systems only.

Unit 3

Asymmetric synthesis: Stereo selective - Stereo specific - Regioselective and Regiospecific reactions. Principle of protection of alcohol, amine, carboxyl and

carbonyl groups - Functional group inter conversions - Disconnection approach - Reversal of polarity - reagents in synthesis.

TEXTBOOKS:

1. *E. L. Eliel, "Stereochemistry of Carbon Compounds", McGraw-Hill Book Co, (2000).*
2. *Jerry March, "Advanced Organic Chemistry", 4th edition, John Wiley & Sons, (1992).*

REFERENCES:

1. *S. Warren, "Designing Organic Synthesis", Wiley & Sons, (1998).*
2. *Finar I. L, "Organic Chemistry: Stereochemistry and the Chemistry of Natural Products", 5th edition, ELBS, (2000).*

15CHY250 POLYMER MATERIALS AND PROPERTIES 3 0 0 3

Unit 1

Structure of polymers – thermoplastic, thermoset, rubber - Linear, branched, crosslinked, and network polymers – polymerization types – addition, condensation, mechanism, methods – bulk, solution, suspension and emulsion - crystalline, amorphous, orientation – molecular weight – intermolecular forces, solubility parameter - glass transition temperature.

Unit 2

Manufacturing, mechanical, thermal, electrical and chemical properties and applications of commodity plastics - PE, PP, PVC, PS, Engineering plastics - ABS, PC, PMMA, polyamide, polyacetal, PET, PBT, PTFE, High performance polymer - PES, PEI, PEEK, conducting polymer.

Unit 3

Thermoset materials - PF, UF, MF, epoxy and unsaturated polyester resin, Rubber - natural rubber, synthetic rubber - SBR, PB, nitrile, chloroprene, butyl, silicone - compounding and additives.

TEXTBOOKS:

1. *J. A. Brydson, "Plastics Materials" Butterworth-Heinemann – Oxford, 7th Ed., London, 1999*
2. *Maurice Morton, "Rubber Technology", 3rd Ed, Kluwer Academic Pub, Dordrecht, Netherlands, 1999*
3. *Manas Chanda and Salil K. Roy, "Plastics Technology Handbook", CRC Press, Atlanta, 2007*

REFERENCE BOOKS:

1. *D. W. Van Krevelena and P. J. Hoftyzen, "Properties of Polymer", 3rd Edition Elsevier Scientific Publishing Company Amsterdam – Oxford – Newyork. 1990.*
2. *Jozef Bicerano, "Prediction of Polymer Properties", Second Edition, Marcel Dekker Inc. New York,1995.*

15CHY251 POLYMERS FOR ELECTRONICS 3 0 0 3

Unit 1

Conducting polymers: Conducting mechanisms - Electron transport and bipolar polymers - electrodepositable resists, resins. Applications - Organic light emitting diodes, Sensors, EMI shielding, printed Circuit Boards, Artificial nerves, Rechargeable Batteries, Electromechanical Actuators and switches.

Unit 2

Photoconductive polymers: Charge carriers, charge injectors, charge transport, charge trapping. Polymers for optical data storage - principles of optical storage, polymers in recording layer.

Nonlinear optics: NLO properties and NLO effects, wave guide devices, polymer optical fibers - through plane modulators.

Unit 3

Thermosensitive polymers: Applications - Mechanical actuators and switches - Tissue culture, Drug delivery, Photo resists - Types - Chemically amplified photoresists - Applications. Magnetic polymers - structure and Applications.

Liquid crystalline polymers: Fundamentals and process, liquid crystalline displays - Applications.

TEXTBOOK:

Kiichi Takemoto, Raphael M. Ottenbrite, Mikiharu Kamachi, "Functional Monomers and Polymers", CRC Press, (1997).

REFERENCES:

1. *A B Kaiser, "Electronic properties of conjugated polymers - basics, models and applications", Springer Verlag, (1987).*
2. *J. A. Chilton and M T Goosy, "Special polymers for electronics and optoelectronics", Kluwer Academic Publishers, (1995).*

15CHY252 SOLID STATE CHEMISTRY 3 0 0 3

Unit 1

Symmetry in Crystal Systems: Types of symmetry, plane, axis and centre of symmetry, crystal systems and symmetry elements. Law of rational indices, miller indices, Weiss indices - plane systems, space lattices, unitcells - unitcell dimension, determination. Space lattice - definition and types Bravais lattice - kinds of bravais lattices, number of atoms in SC, BCC, FCC lattices, void space, Radius ratio rule and application. Crystal defects - types of defects in crystals - stoichiometric

defect - schottky and frenkel defects - Non-stoichiometric defects - metal excess and metal deficiency defects, influence of defects on the properties of solids.

Unit 2

Electrical and Magnetic Properties: Development of free electron theory to band theory of solids - metals and their properties; semiconductors - extrinsic and intrinsic, Hall effect; Insulators - dielectric, ferroelectric, pyroelectric and peizoelectric properties and the relationship between them. Dia, para, ferro, ferri, antiferro and antiferri magnetic types - selected magnetic materials such as spinels, garnets and perovskites, superconductors.

Diffraction Methods: X-ray diffraction - various methods of X-ray analysis of structure-ray diffraction pattern, X-ray scattering factor. Results and uses of X-ray diffraction. Limitations of X-ray diffractions.

Unit 3

Neutron diffraction - principles, electron diffraction patterns, limitations - applications of electron diffraction - structural elucidation. Distinction between X-ray, Neutron and electron diffraction. Structure factor - definition, factors influencing structure factor. Uses of structure factor.

Fourier synthesis - definition, applications of fourier synthesis in crystal structure analysis of S-Tetrazine. Structure of Rutile, Fluorite, Antifluorite, Zinc blende, Wurtzite, diamond and graphite.

REFERENCES:

1. *Cotton F. A, Wilkinson G and Gaus P, "Basic Inorganic Chemistry", 3rd edition, John Wiley and Sons, (2003).*
2. *Shriver D. F and Atkins P. W, "Inorganic Chemistry", 3rd edition, ELBS, Oxford University Press, Oxford, (2004).*
3. *Huheey J. E, Keiter E. A and Keiter R. L, "Inorganic Chemistry", 4th edition, Addison-Wesley Pub. London, (1993).*
4. *Cotton F. A, Wilkinson G, Murillo C. A and Bochmann M, "Advanced Inorganic Chemistry", 6th edition, John Wiley and Sons, New York, (2003).*
5. *Jolly W. L, "Modern Inorganic Chemistry", 2nd edition, McGraw-Hill, Inc., (1991).*
6. *Miessler G. L and Tarr D. A, "Inorganic Chemistry", 3rd edition, Pearson Education, Singapore, (2004).*

15CHY331 BATTERIES AND FUEL CELLS 3 0 0 3

Unit 1

Background Theory: Origin of potential - electrical double layer - reversible electrode potential - standard hydrogen electrode - emf series - measurement of potential -

reference electrodes (calomel and silver/silver chloride) indicator and ion selective electrodes - Nernst equation - irreversible processes - kinetic treatment - Butler-Volmer equation - Overpotential, activation, concentration and IR overpotential - its practical significance - Tafel equation and Tafel plots - exchange current density and transfer coefficients.

Unit 2

Batteries: Primary batteries: The chemistry, fabrication and performance aspects, packing classification and rating of the following batteries: (The materials taken their function and significance, reactions with equations, their performance in terms of discharge, capacity, and energy density to be dealt with). Zinc-carbon (Leclanche type), zinc alkaline (Duracell), zinc/air batteries; Lithium primary cells - liquid cathode, solid cathode and lithium-ferrous sulphide cells (comparative account).

Secondary batteries: Lead acid and VRLA (valve regulated (sealed) lead acid), nickel-cadmium, nickel-zinc, nickel-metal hydride batteries, lithium ion batteries, ultrathin lithium polymer cells (comparative account). Advanced Batteries for electric vehicles, requirements of the battery - sodium-beta and redox batteries.

Unit 3

Fuel Cells: Description, working principle, anodic, cathodic and cell reactions, fabrication of electrodes and other components, applications, advantages, disadvantages and environmental aspects of the following types of fuel cells: Proton Exchange Membrane Fuel Cells, alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate, direct methanol fuel cells.

Membranes for fuel cells: Nafion – Polymer blends and composite membranes; assessment of performance – recent developments.

Fuels for Fuel Cells: Hydrogen, methane, methanol - Sources and preparation, reformation processes for hydrogen – clean up and storage of the fuels – use in cells, advantages and disadvantages of using hydrogen as fuel.

TEXTBOOKS:

1. *Dell, Ronald M Rand, David A J, 'Understanding Batteries', Royal Society of Chemistry, (2001).*
2. *M. Aulice Scibioh and B. Viswanathan 'Fuel Cells – principles and applications', University Press, India (2006).*

REFERENCES:

3. *Kanani N, 'Electroplating and electroless plating of copper and its alloy', ASM International, Metals Park, OH and Metal Finishing Publications, Stevenage, UK (2003).*
4. *Curtis, 'Electroforming', London, (2004).*

5. F. Barbir, 'PEM fuel cells: theory and practice', Elsevier, Burlington, MA, (2005).
6. G. Hoogers, 'Fuel cell handbook', CRC, Boca Raton, FL, (2003).

15CHY332 CORROSION SCIENCE 3 0 0 3

Unit 1

Basic principles: Free energy concept of corrosion - different forms of corrosion - Thermodynamic & Kinetic aspects of corrosion: The free energy criterion of corrosion possibility - Mechanism of Electrochemical corrosion - Galvanic and Electrochemical series and their significance.

Corrosion Control: Materials selection - metals and alloys - metal purification - non metallic - changing medium.

Unit 2

Anodic and cathodic protection methods - Coatings - metallic and other inorganic coatings - organic coatings - stray current corrosion - cost of corrosion control methods.

Corrosion protection by surface treatment: CVD and PVD processes - Arc spray - Plasma spray - Flame spray.

Corrosion Inhibitors: Passivators - Vapour phase inhibitor.

Unit 3

Stress and fatigue corrosion at the design and in service condition - control of bacterial corrosion.

Corrosion protection: Automobile bodies – engines – building construction.

TEXTBOOKS:

1. Fontana and Mars G, "Corrosion Engineering", 3rd edition, McGraw-Hill, (1987).
2. Uhlig H H and Reviees R W, "Corrosion and its Control", Wiley, (1985).

REFERENCES:

1. ASM Metals Handbook, "Surface Engineering", Vol. 5, ASM Metals Park, Ohio, USA, (1994).
2. ASM Metals Handbook, "Corrosion", Vol. 13, ASM Metals Park, Ohio, USA, (1994).
3. Brain Ralph, "Material Science and Technology", CRC Series, Boston, New York.

15CSE100 COMPUTATIONAL THINKING AND PROBLEM SOLVING 3 0 2 4

Unit 1

Basics: Introduction, Information and data, Data encoding. Logic: Boolean logic, Applications of propositional logic.

Unit 2

Problem Solving and Algorithmic Thinking: Problem definition, Logical reasoning, Problem decomposition, Abstraction. Flowcharting, Name binding, Selection, Repetition, Modularization. Data organization: List and Arrays. Simple algorithms, comparison of performance of algorithms.

Unit 3

Problem Solving Techniques: Factoring and Recursion Techniques, Search and Sort techniques, Text processing and Pattern matching.

TEXTBOOKS:

1. David Riley and Kenny Hunt, Computational Thinking for Modern Solver, Chapman & Hall / CRC, 2014
2. R. G. Dromey, "How to solve it by Computer", PHI, 2008

15CSE102 COMPUTER PROGRAMMING 3 0 0 3

Unit 1

Introduction to C language: Structure of a C program, comments, Data types, Variables, constants, Data input and output statements, input assertions; expressions and evaluation. Functions: inter function communication, standard functions, scope. Selection: two way selection, multi-way selection, repetition: concept of loop, loop invariant, pretest and post-test loops, initialization and updating, event and counter controlled loops. Recursion: recursive definition, recursive solution, designing recursive functions, limitations of recursion.

Unit 2

Files and streams, file input output. Arrays - 1D numeric, searching and sorting, 2D numeric arrays: problems with matrices. Pointers: introduction, compatibility, arrays and pointers, Dynamic memory allocation, array of pointers, pointer arithmetic.

Unit 3

Strings: fixed length and variable length strings, strings and characters, string input output, array of strings, string manipulation functions, sorting of strings. Enumerated types, Structures: Structure vs array comparison, complex structures, Structures and functions, Union, binary input output, Command line arguments.

TEXTBOOK:

Behrouz A. Forouzan and Richard F. Filberg, "Computer Science A structured programming approach using C", Third Edition, Cengage Learning, 2006.

REFERENCES:

1. Brian W. Kernighan, Dennis M. Ritchie, "The C Programming Language", Second Edition, Prentice Hall, 1988.

2. *Eric S. Roberts, "Art and science of C", Addison Wesley, 1995.*
3. *Jeri Hanly and Elliot Koffman, "Problem solving and program design in C", Fifth Edition, Addison Wesley (Pearson), 2007.*

15CSE111 COMPUTER SCIENCE ESSENTIALS 3 0 0 3

Unit 1

Introduction to Computer Science: Role of Algorithms, History of Computing, Science of Algorithms, Abstractions. Basics of data encoding and storage: Bits and their storage, Main memory, Mass Storage, Representing Information as Bit Patterns. Machine Architecture: CPU Basics, Stored Program concepts, Machine Language Introduction with example, Program Execution with illustrative example.

Unit 2

Operating Systems: History of OS, OS Architecture, Coordinating Machine Activities. Networking and the Internet: Network Fundamentals, The Internet, The World Wide Web. Software Engineering: Introduction, Software Life Cycle. Database Systems: Database Fundamentals, Relational Model.

Unit 3

Computer Graphics: Scope of Computer Graphics, Overview of 3D Graphics. Artificial Intelligence: Intelligence and Machines, Perception, Reasoning. An Introduction to topics of research in the department.

TEXTBOOK:

J. Glenn Brookshear, "Computer Science: An Overview", Addison-Wesley, Twelfth Edition, 2014.

15CSE180 COMPUTER PROGRAMMING LAB. 0 0 2 1

Solving simple problems with operators, programs on conditional control constructs, programs on loops (while, do-while, for), programs using user defined functions and library functions, programs on Files, arrays, matrices (single and multi-dimensional arrays), programs using DMA, programs on strings, structures.

REFERENCE:

Behrouz A. Forouzan and Richard F. Filberg, "Computer Science A structured programming approach using C", Third Edition, Cengage Learning, 2007.

15CSE201 DATA STRUCTURES AND ALGORITHMS 3 1 0 4

Unit 1

Introduction: Overview of Data Structures – A Philosophy of Data Structures - The Need for Data Structures – Cost and Benefits - Abstract Data Types and Data

Structures - Principles, and Patterns. Basic complexity analysis – Best, Worst, and Average Cases - Asymptotic Analysis -Analyzing Programs – Space Bounds, Arrays, Linked Lists and Recursion: Using Arrays - Lists - Array based List Implementation – Linked Lists – LL ADT – Singly Linked List – Doubly Linked List – Circular Linked List – recursion- linear, binary, and multiple recursions.

Stacks and Queues: Stack ADT - Array based Stacks, Linked Stacks – Implementing Recursion using Stacks, Queues - ADT, Array based Queue, Linked Queue, Double-ended queue, Circular queue.

Unit 2

Trees: Tree Definition and Properties – Tree ADT - Basic tree traversals - Binary tree - Data structure for representing trees – Linked Structure for Binary Tree – Array based implementation. Priority queues: ADT – Implementing Priority Queue using List – Heaps. Maps and Dictionaries: Map ADT – List based Implementation – Hash Tables - Dictionary ADT - Skip List – Complexity.

Unit 3

Search trees – Binary search tree, AVL tree, Trees – K-D Trees - B-Trees. Sorting and Selection – Linear Sorting – Heap Sort - Divide and Conquer Strategy – Analysis using Recurrence Tree based Method - Merge Sort - Quick Sort - Studying Sorting through an Algorithmic Lens – Selection – External Memory Sorting and Searching. Graphs: ADT- Data structure for graphs - Graph traversal- Transitive Closure- Directed Acyclic graphs - Weighted graphs – Shortest Paths - Minimum spanning tree – Greedy Methods for MST.

TEXTBOOKS:

1. *Goodrich M T and Tamassia R, "Data Structures and Algorithms in Java", Fifth edition, Wiley publication, 2010.*
2. *Clifford A. Shaffer, "Data Structures and Algorithm Analysis", Third Edition, Dover Publications, 2012.*

REFERENCES:

1. *Goodrich M T, Tamassia R and Michael H. Goldwasser, "Data Structures and Algorithms in Python++", Wiley publication, 2013.*
2. *Tremblay J P and Sorenson P G, "An Introduction to Data Structures with Applications", Second Edition, Tata McGraw-Hill, 2002.*

15CSE202 OBJECT - ORIENTED PROGRAMMING 3 0 0 3

Unit1

Introduction to object oriented software design, Comparison of programming methodologies, Object Basics, Java Environment, Classes and Object, Data

Members, Access Specifiers, Arrays within a Class, Array of Objects, Constructors, Default Constructors, Destructors, Static Members, Constant Members, Object Oriented Design with UML, Class, object diagrams and sequence diagrams.

Unit 2

Overview of Streams, Bytes vs. Characters, File Object, Binary Input and Output, Reading and Writing Objects, Method Overriding, Polymorphism, Inheritance, Interfaces and Abstract Classes, Packages, Use case diagrams and activity diagrams.

Unit 3

Introduction to Threads, Creating Threads, Thread States, Runnable Threads, Coordinating Threads, Interrupting Threads, Runnable Interface Applets: Applet Architecture - Parameters to Applet - Embedding Applets in Web page, Component diagrams and Deployment diagrams.

TEXTBOOK:

1. *Naughton P. and Schildt H., "Java2 Complete Reference", Eighth Edition, Tata McGraw- Hill, 2011.*
2. *Ali Bahrami, "Object Oriented Systems Development", Second Edition, McGraw-Hill,2008.*

REFERENCES:

1. *Grady Booch and Robert A. Maksimchuk, "Object-oriented Analysis and Design with Applications", Third Edition, Pearson Education, 2009.*
2. *Jaime Nino, Fredrick AHosch, "An Introduction to Programming and Object Oriented Design using Java", Wiley India PrivateLimited, 2010.*

15CSE211 DESIGN AND ANALYSIS OF ALGORITHMS 3 1 0 4

(Pre-requisite: 15CSE201 Data Structures and Algorithms)

Unit 1

Introduction - Algorithms vs programs. Flow charts and pseudo code, Rate of growth of functions. Asymptotic notation: motivation and types of notations. Recurrence relations and methods to solve them: Recursion tree, substitution, Master Method, Sorting: Bubble – Insertion – Selection – Bucket – Heap, Comparison of sorting algorithms, Divide and Conquer: Quick sort – Merge sort – Binary search – Long integer multiplication – Maximum sub array sum.

Unit 2

Greedy Algorithm - Introduction to the method, Fractional Knapsack problem, Task Scheduling Problem, Dynamic Programming: Introduction to the method, Fibonacci numbers, 0-1 Knapsack problem, Matrix chain multiplication problem. Backtracking, Branch and Bound 0-1 Knapsack, N- Queen problem.

Unit 3

Graph Algorithms - Graph Traversal: Applications of BFS: distance, connectivity and connected components and cycles in undirected graphs. Applications of DFS: Topological sort, cycles in directed graphs, Biconnected Components and Strong Connectivity. Path algorithms: Shortest path algorithms (along with analysis) SSSP: Bellman Ford. APSP: Floyd Warshall's. Minimum Spanning Tree (with analysis and applications). Introduction to NP class: Definitions P, NP, NP complete, NP hard, Examples of P and NP.

TEXTBOOK:

Goodrich M T and Tamassia R, "Algorithm Design Foundations - Analysis and Internet Examples", John Wiley and Sons, 2007.

REFERENCES:

1. *Cormen T H, Leiserson C E, Rivest R L and Stein C, "Introduction to Algorithms", Prentice Hall of India Private Limited, Third Edition, 2009.*
2. *Dasgupta S, Papadimitriou C and Vazirani U, "Algorithms", Tata McGraw-Hill, 2009.*

15CSE212 INTRODUCTION TO EMBEDDED SYSTEMS 3 0 0 3

Unit 1

Architecture of Microprocessors: General definitions of computers, microprocessors, micro controllers and digital signal processors. Overview of Intel microprocessors: Introduction to 8086 microprocessor, Signals and pins of 8086 microprocessor, Addressing Modes, Instruction set, Assembler directives, simple programs, procedures, and macros. Pin diagram of 8086 - Minimum mode and Maximum mode of operation. Timing diagram. Memory interfacing to 8086 (Static RAM & EPROM). Need for DMA. DMA data transfer Method.

Introduction to 80486, Pentium, and Core Architectures.

Unit 2

ARM Architecture: RISC Machine, Architectural inheritance, Programmers model. ARM Organization and Implementation: 3-stage pipeline, 5-stage pipeline, ARM instruction execution, ARM implementation, Co-processor interface. ARM Assembly Language Programming: Data processing instructions, Data transfer instructions, Control flow instructions, Architectural support for high-level programming, Thumb instruction set.

Unit 3

Interrupt structure of 8086 and ARM: Vector interrupt table, Interrupt service routines, Introduction to DOS and BIOS interrupts for 8086. Asynchronous and Synchronous data transfer schemes. ARM memory interface, AMBA interface. A/D converters, PWM, Timer / Counter, UART and its interfacing - Application development using Keil IDE.

TEXTBOOK:

1. *Barry B Brey, "The Intel Microprocessors 8e (VTU): 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro Processor, Pentium II, Pentium III, Pentium 4 and Core2 with 64-bit Extensions", Pearson Education, Eight Edition, 2012.*
2. *Steve Furber. "ARM system On-Chip-Architecture", Second Edition, Addison Wesley, 2000.*

REFERENCES:

1. *Douglas Hall, "Microprocessors and its Interfacing (SIE)", McGraw Hill Education (India), Third Edition, 2012.*
2. *Yu-Cheng Liu & Glenn A Gibson, "Microcomputer systems 8086/8088 family, Architecture, Programming and Design", Prentice Hall, Second Edition, July 2003.*
3. *Arnold S. Berger, "Embedded System Design", CMP Books, First Edition, Taylor & Francis, 2002.*
4. *Michael Barr, "Programming Embedded Systems with C and GNU", First Edition, O Reilly, 2003.*

15CSE213 OPERATING SYSTEMS 3 1 0 4

Unit 1

Introduction to Operating Systems: Overview - Types of systems - Computer system operations - Hardware Protection - Operating systems services - System calls - System structure - Virtual machines. Process Management: Process concepts - Process scheduling - Operations on Process - Cooperating process - Interprocess communication - Multithreading models - Threading issues - Thread types - CPU scheduling –scheduling algorithms.

Unit 2

Process Synchronization: Critical section problem - synchronization hardware – Semaphores - Classical problems of synchronization - Critical regions – Monitors – Deadlocks - Deadlock characterization - Methods of handling deadlocks - Deadlock prevention – Avoidance - Detection and recovery.

Unit 3

Storage Management: Memory management – Swapping - Contiguous memory allocation. Paging – Segmentation - Segmentation with Paging - Virtual memory - Demand paging - Process creation – page replacement - Thrashing. File Systems: Directory structure - Directory implementation - Disk scheduling. Case study: Threading concepts in Operating systems, Kernel structures.

TEXTBOOK:

Silberschatz and Galvin, "Operating System Concepts", Ninth Edition, John Wiley and Sons, 2012.

REFERENCES:

1. *Deitel. Deitel and Choffnes, "Operating System", Third edition, Prentice Hall, 2003.*
2. *Tannenbaum A S, "Modern Operating Systems", Third edition, Prentice Hall, 2007.*

3. *Stevens W R and Rago S A, "Advanced Programming in the Unix Environment", Second Edition, Addison-Wesley, 2013.*
4. *Gary Nutt, "Operating Systems", Third Edition, Pearson Education, 2009.*

15CSE281 DATA STRUCTURES LAB. 0 0 2 1

Object Oriented Programming, Using Arrays and Array Lists, Linked list: Implementation using Arrays, Application of Linked Lists, Stacks: Array implementation, Linked Implementation, and Applications, Queues: Array implementation, Linked Implementation and Applications, Using linear data structures in Recursion, Scheduling, and other practical applications, Implementing Priority Queues and using existing implementation for applications, Binary search tree and Application, Graph ADT, Traversal, Modelling Problems using Graphs, Minimum Spanning Trees, Hash Table and Dictionary Applications.

15CSE282 OBJECT - ORIENTED PROGRAMMING LAB. 0 0 2 1

Input / Output statements, Manipulators, Structures, Classes, Objects, Static members and functions, Constructors and destructors, Constructor overloading, Function overloading, Forms of inheritance, Exception handling, Interfaces, Multithreading, Thread Synchronization, Applets.

15CSE285 EMBEDDED SYSTEMS LAB. 0 0 2 1

Intel 8086 Assembly program for Arithmetic and Logical Operations, Intel 8086 Procedures and Macros, ARM Assembly program for Arithmetic and Logical Operations, ARM Assembly program for Multi-byte Operations, ARM Assembly program for Control Manipulation, ARM Assembly program for String Manipulation, ARM Assembly program for Thumb Instructions, Embedded C Programming using Keil Simulator - Simple C Programs, Port Programming. Peripheral Interfacing – Keypad, Motor, LED.

15CSE286 OPERATING SYSTEMS LAB. 0 0 2 1

Unix Commands - Shell scripts – Awk programming - Process Management: Process creation, Thread Creation - Interprocess Communication: Pipes and Shared memory - Scheduling algorithms: First Come First Serve, Shortest Job First, Priority, Round Robin – Process Synchronisation: Critical Section problem for two processes, Semaphores, Classical problems in Semaphores – Deadlock Management: Banker's algorithm of Deadlock Avoidance, Deadlock Detection algorithm - Memory Management: Page replacement policies.

Case Study / project: Mobile OS: Android, iOS – NachOS / Minix / Linux Kernel: study of any one module

15CSE301 COMPUTER ORGANIZATION AND ARCHITECTURE 3 0 0 3

Unit 1

Introduction and Performance of Computing system, Processor Architecture with example as MIPS & Instruction Set, Single Cycle Datapath Design, Control Hardware, Computer Arithmetic, Floating Point Arithmetic, Role of performance.

Unit 2

Introduction to multicycle datapath, Pipelining Technique – Design Issues, Hazards: Structural Hazards, Data Hazards and Control Hazards, Static Branch Prediction, Dynamic Branch Prediction, Advanced Concepts in pipelining.

Unit 3

Memory Organization - Introduction, Cache Memory Organization, Main Memory & Interleaving, I/O Organization, Modern Processors, Parallel Processing.

TEXTBOOKS:

1. *Patterson, David A and J L Hennessy, "Computer Organisation & Design, The Hardware/ Software Interface (ARM Edition)", Morgan Kaufmann, Fifth Edition, Newness, 2013.*
2. *Hennnessy and Patterson, "Computer Architecture: A Quantitative Approach", Elsevier, Fifth Edition, 2011.*
3. *W Stallings, "Computer Organisation & Architecture: Designing for Performance", Pearson, Eighth Edition, 2010*
4. *V. Carl Hamacher, Zvonko G. Varanesic and Safat G. Zaky, "Computer Organisation", Fifth Edition, McGraw Hill Education (India), 2011.*

15CSE302 DATABASE MANAGEMENT SYSTEMS 2 0 2 3

Unit 1

Introduction: Overview of DBMS, File vs DBMS, elements of DBMS. Database design: E-R model, Notations, constraints, cardinality and participation constraints, ER design issues, Weak and strong entity sets, Extended ER features. Relational Data Model: Introduction to relational model, Structure of relational mode, domain, keys, tuples to relational models.

Unit 2

Relational Database Design: Functional dependency, Normalization: 1NF, 1NF, 2NF, 3NF, BCNF, Relational Synthesis algorithm, Lossless join testing algorithm, Decomposition Using Functional Dependencies, Functional-Dependency Theory - Reduction of ER model to Relational model. SQL: Various DDLs, DMLs, DCLs.

Unit 3

Indexing Mechanisms: Clustered, Non-Clustered, B-tree, B+tree, Hash based. Transactions: Transaction Concept, Transaction model, Storage Structure, Transaction Atomicity and Durability, Transaction Isolation, Serializability Concurrency control: Lock-based protocols – Locks, Granting of Locks, The Two-Phase Locking Protocol, Implementation of Locking, Graph-Based Protocols. Deadlock handling: Deadlock Prevention, Deadlock Detection and Recovery, Deadlock Detection, Recovery from Deadlock.

TEXTBOOK:

Silberschatz A, Korth H F and Sudharshan S, "Database System Concepts", Sixth Edition, Tata McGraw-Hill Publishing Company Limited, 2011.

REFERENCES:

1. *Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom, "Database Systems: The Complete Book", Second edition, 2011.*
2. *Elmasri R and Navathe S B, "Fundamentals of Database Systems", Fifth Edition, Addison Wesley, 2006.*
3. *Ramakrishnan R and Gehrke J, "Database Management Systems", Third Edition, McGraw-Hill, 2003.*

15CSE303 THEORY OF COMPUTATION 3 0 0 3

Unit 1

Automata and Languages: Chomsky hierarchy of languages, Introduction Finite Automata - Regular Expressions - Nondeterministic Finite Automata - equivalence of NFAs and DFAs – Minimization of DFA.

Unit 2

Regular Expressions - Non-Regular Languages - Pumping Lemma for regular languages.

Unit 3

Parse tree derivations (top-down and bottom-up) Context free languages – Chomsky normal form, GNF - Push Down Automata - Pumping lemma for context free language. CYK Algorithm, Deterministic CFLs. Ambiguous grammar, removing ambiguity, Computability Theory: Turing Machines - Non-deterministic Turing Machines – CSG, Undecidability - PCP Computation histories – Reducibility.

TEXTBOOK:

Linz P, "An Introduction to Formal Languages and Automata", Fourth Edition, Narosa Publishing House, 2009

REFERENCES:

1. *Michael Sipzer, "Introduction to the Theory of Computation", Third Edition, Cengage Learning, 2012.*

2. *Martin and John, "Introduction to Languages and the Theory of Computation", New York, McGraw Hill, 2002.*
3. *Garey, Michael and Johnson D S, "Computers and Intractability: A Guide to the Theory of NP - Completeness", New York, W.H. Freeman and Company, First Edition, 1979.*
4. *J E Hopcroft, R Motwani and J D. Ullman, "Introduction to Automata Theory, Languages, and Computation", Third Edition, Addison-Wesley, 2007.*

15CSE311 COMPILER DESIGN 3 1 0 4

Unit 1

Overview of Compilation: Compiler Structure – Overview of Translation. Lexical Analysis: Regular Expressions – From Regular Expression to Scanner – Implementing Scanners. Parsers: Expressing Syntax – Top-Down and Bottom-Up Parsing – LR(0), LR(1) and LALR(1).

Unit 2

Context-Sensitive Analysis: Type Systems – Attribute - Grammar – Syntax Directed Translation, Intermediate Representations: Graphical and Linear Intermediate Representations – Symbol Tables. Procedure Abstraction: Procedure Calls – Name Spaces – Communicating Values between Procedures.

Unit 3

Iterative Data Flow Analysis – Instruction Selection via Tree-Pattern Matching – Register.

Allocation: Local and Global – Introduction to Optimization.

TEXTBOOK:

Keith Cooper and Linda Torczon, "Engineering a Compiler", Second Edition, Morgan Kauffman,2011.

REFERENCES:

1. *Ronald Mak, "Writing Compilers and Interpreters: A Software Engineering Approach", John Wiley & Sons, Third Edition, 2009.*
2. *Andrew W. Appel and Jens Palsberg, "Modern Compiler Implementation in Java", Cambridge University Press, Second Edition, 2002.*
3. *Alfred V. Aho, Monica S. Lam, Ravi Sethi and Jeffrey D. Ullman, "Compilers: Principles, Techniques and Tools", Prentice Hall, Second Edition, 2006.*

15CSE312 COMPUTER NETWORKS 3 0 0 3

Unit 1

The Internet - The Network Edge, the Network Core, Delay, Loss, and Throughput in Packet Switched Networks, Protocol Layers and Their Service Models. Principles of Network Applications: The Web and HTTP, File Transfer: FTP, Electronic Mail in the Internet, DNS - The Internet's Directory Service, Peer-to-Peer Applications.

Introduction and Transport Layer Services: Multiplexing and Demultiplexing, Connectionless Transport - UDP, Principles of Reliable Data Transfer.

Unit 2

Transport layer - Connection Oriented Transport - TCP, Principles of Congestion Control, TCP Congestion Control. Introduction Network Layer: Virtual Circuit and Datagram Networks, Inside a Router, The Internet Protocol (IP) - Forwarding and Addressing in the Internet, Routing Algorithms, Routing in the Internet, Broadcast and Multicast Routing.

Unit 3

The Link Layer and Local Area Networks - Introduction and Services, Error-Detection and Correction Techniques, Multiple Access Protocols, Link-Layer Addressing, Ethernet, Link-Layer Switches, PPP - The Point-to-Point Protocol.

TEXTBOOK:

Kurose J F and Ross K W, "Computer Networking: A Top-Down Approach", Sixth Edition, Pearson Press, 2013.

REFERENCES:

1. *Tanenbaum A S, "Computer Networks", Third Edition, PHI, 2004.*
2. *Stallings W, "Data and Computer Communications", Seventh Edition, Pearson Education Asia, 2004.*
3. *Forouzan B A, "Data Communication and Networking", Third Edition, Tata McGraw Hill, 2004.*

15CSE313 SOFTWARE ENGINEERING 2 0 2 3

Unit 1

Software Engineering Concepts - A Generic view of Process - Categories of Software - Process Models - Perspective models - Waterfall model - Incremental models - Evolutionary models - Specialized models - Unified Process Models. Requirements Engineering: Tasks Initiation – Elicitation - Developing Use Cases - Building the analysis model – Negotiation - Validation - Building the Analysis Model.

Unit 2

Requirement Analysis – Approaches - Data modelling concepts - OO Analysis - Scenario Based modelling - Flow Oriented modelling - Class based modelling -

Behavioural Modelling. Design Engineering: Design Process and Quality - Design Concept – Model - Creating an Architectural Design - Software Architecture - Data Design - Architectural Styles and Patterns - Architectural Design - Mapping Data Flow into Software Architecture – Modelling Component level design – Component-Class based Components - Conducting component level design -Designing conventional components.

Unit 3

Performing user interface design - Golden Rules - User interface Analysis and Design - Interface Analysis - Interface design steps - Web Engineering - Attributes, Layers, Processes and best Practices - Initiating, Analysis, Design and Testing of Webapp projects, Testing Strategies: Testing Tactics - Testing fundamentals - Black-box and White-box Testing - Product Metrics. Case Study: SWEBOK.

TEXTBOOK:

Pressman R S, Bruce R.Maxim, "Software engineering - A Practitioner's Approach", Eighth Edition, Tata McGraw-Hill, 2014.

REFERENCES:

1. *Sommerville I, "Software Engineering", Sixth Edition, Addison Wesley, 2003.*
2. *Fairley R, "Software Engineering Concepts", Seventh Edition, Tata McGraw-Hill, 1999.*
3. *G J Myers, Corey S, Tom B and Todd M T, "The Art of Software Testing", Third Edition, Wiley, 2011.*
4. *Pankaj J, "An Integrated Approach to Software Engineering", Third Edition, Narosa Publishing House, 2005.*

15CSE330 INFORMATION TECHNOLOGY ESSENTIALS 3 0 0 3

Unit 1

Computer hardware and system software concepts: Computer Architecture, system software, Operating Systems, Computer Networking. Programming fundamentals; problem solving concepts, modular approach through use of functions, error handling techniques, structured Programming and data structures, structured statements, string handling functions, sorting and searching, file handling functions, Object oriented concepts; Managing software complexity, concepts of object oriented programming, abstraction, class, object, member data, member methods, encapsulation, data hiding, inheritance, polymorphism, binding.

Unit 2

Analysis of algorithms; principles and tools for analysis of algorithms, analysis of popular algorithms, code tuning techniques, intractable problems, Relational Database management; basic RDBMS concepts, database design, SQL comments, embedded SQL concepts, OLTP concepts.

Unit 3

System development methodology; software engineering development life cycle (SDLC), quality concepts and quality system procedures, analysis and design methods, structured programming concepts and principles of coding, software testing. User interface design: process of user interface design, elements of user interface design, speech user interface, web design issues. Introduction of web architecture: basic architecture of web application, security, and performance of web based applications, architecture documents.

REFERENCES:

1. *Andrew. S. Tanenbanum, "Structured Computer Organization", Fourth Edition, PHI, 1999.*
2. *Abraham Silberschatz, Henry F Korth, S. Sudharshan, "Database System Concepts", Fourth Edition, Tata McGraw, 1997.*
3. *Roger S Pressman, "Software Engineering – A practitioner's approach", Sixth Edition, McGraw Hill Publishers, 2004.*

15CSE331 ADVANCED ALGORITHMS AND ANALYSIS 3 0 0 3

Unit 1

Algorithm Analysis- Methodologies for Analyzing Algorithms, Asymptotic growth rates, Amortized Analysis. Number Theory: Preliminaries, FLT, Euclid's algorithm (extended). Totient function, Sieve for primes, Inverse modulo n, Modular exponentiation, Applications of graph algorithms: Topological sort, Strongly Connected Components, Bi-connected Components, Bridges, Articulation points. All Pair Shortest Paths, Single Source Shortest Paths. Computational Geometry: Convex Hull, closest pair of points in 2D, the triangle with smallest perimeter in 2D, Determining whether a set of line segments have one or more intersections.

Unit 2

Applications of Divide-and-Conquer, Greedy techniques and Dynamic Programming - Knapsack, Median finding, Scheduling algorithms, Party planning, bitonic TSP etc., String matching algorithms: KMP, Rabin Karp, Aho-Corasick, 2D queries, efficient algorithms for longest palindrome, Longest Common Substring.

Unit 3

Flow Networks: Ford-Fulkerson, Edmonds Karp, Applications of maximum flows - Efficient algorithms for maximum bipartite matching, minimum cost matching. NP-Completeness: Important NP-Complete Problems, Polynomial time reductions, Approximation algorithms, Parallel Algorithms (overview): Tree Contraction - Divide and Conquer - Maximal Independent Set. External-Memory Algorithms - Accounting for the Cost of Accessing Data from Slow Memory – Sorting - B-trees - Cache-oblivious Algorithms for Matrix Multiplication and Binary Search.

TEXTBOOK:

Goodrich M T and Tamassia R, "Algorithm Design and Applications", John Wiley and Sons, 2014.

REFERENCES:

1. *Cormen T H, Leiserson C E, Rivest R L and Stein C, "Introduction to Algorithms", Prentice Hall of India Private Limited, Third Edition, 2009.*
2. *Rajeev Motwani and Prabhakar Raghavan, "Randomized Algorithms", Cambridge University Press, 1995.*
3 *Vijay V. Vazirani., "Approximation Algorithm", Springer, 2003*

15CSE332 ADVANCED COMPUTER ARCHITECTURE 3 0 0 3

Unit 1

Instruction Level Parallelism: ILP – Concepts and challenges – Hardware and software approaches – Dynamic scheduling – Speculation - Compiler techniques for exposing ILP– Branch prediction. VLIW & EPIC – Advanced compiler support – Hardware support for exposing parallelism – Hardware versus software speculation mechanisms – IA 64and Itanium processors – Limits on ILP, Data-Level Parallelism in Vector, SIMD, and GPU Architectures: Introduction – vector architecture – working – performance - SIMD Instruction Set Extensions for Multimedia - Graphics Processing units - GPGPU.

Unit 2

Multiprocessors and Thread level Parallelism: Symmetric and distributed shared memory architectures – Performance issues – Synchronization – Models of memory consistency – Introduction to Multithreading Memory and I/O: Cache performance – Reducing cache miss penalty and miss rate – Reducing hit time – Main memory and performance – Memory technology. Types of storage devices – Buses – RAID – Reliability, availability and dependability – I/O performance measures – Designing an I/O system.

Unit 3

Multi-Core Architectures: Software and hardware multithreading – SMT and CMP architectures – Design issues – Case studies – Intel Multi-core architecture – SUN CMP architecture - heterogeneous multi-core processors – case study: IBM Cell Processor.

TEXTBOOK:

John L. Hennessey and David A. Patterson, "Computer architecture – A Quantitative approach", Morgan Kaufmann / Elsevier Publishers, Fifth edition, 2012.

REFERENCES:

1. *David E. Culler and Jaswinder Pal Singh, "Parallel computing architecture: A hardware / software approach", Morgan Kaufmann, Elsevier Publishers, 1999.*
2. *Kai Hwang and Zhi.Wei Xu, "Scalable Parallel Computing", Tata McGraw Hill, New Delhi, 2003.*

15CSE333 ADVANCED DATABASE MANAGEMENT SYSTEMS 2 0 2 3

Unit 1

Overview of DBMS – Database design – Query processing. Data modeling – ER – EER –Object Oriented Databases – Object Relational Databases, Document oriented Databases – Background of NoSQL – XML document – Structure of XML Data – XML Document Schema – Querying and Transformation – API – Storage of XML Data – XML Applications.

Unit 2

Information Retrieval Systems, Databases – Multidimensional Indexes - Data Cubes, Grid Files, R-trees.

Unit 3

Distributed Databases – Data Distribution – Distributed Transactions, Parallel Databases – Performance measure - Parallel operations for relational operations, Information Integration – Federated Database – Data Warehouses – Mediators – Schema matching methods.

TEXTBOOK:

Silberschatz, Korth and Sudarshan, "Database Concepts", Sixth Edition, Tata McGraw Hill,2010.

REFERENCES:

1. *Hector Garcia-Molina, Jeff Ullman, and Jennifer Widom, "Database Systems: The Complete Book", Pearson, 2011.*
2. *Niall O'Higgins, "Mongo D B and Python", O'reilly, 2011.*

15CSE334 BIG DATA ANALYTICS 3 0 0 3

Unit 1

Introduction to Big Data: Types of Digital Data-Characteristics of Data – Evolution of Big Data - Definition of Big Data - Challenges with Big Data - 3Vs of Big Data - Non Definitional traits of Big Data - Business Intelligence vs. Big Data - Data warehouse and Hadoop environment - Coexistence. Big Data Analytics: Classification of analytics - Data Science - Terminologies in Big Data - CAP Theorem - BASE Concept. NoSQL: Types of Databases – Advantages – NewSQL - SQL vs. NOSQL vs NewSQL. Introduction to Hadoop: Features – Advantages – Versions - Overview of Hadoop Eco systems - Hadoop distributions - Hadoop vs. SQL – RDBMS vs. Hadoop - Hadoop Components – Architecture – HDFS - Map Reduce: Mapper – Reducer – Combiner – Partitioner – Searching – Sorting - Compression. Hadoop 2 (YARN): Architecture - Interacting with Hadoop Eco systems.

Unit 2

No SQL databases: Mongo DB: Introduction – Features - Data types - Mongo DB Query language - CRUD operations – Arrays - Functions: Count – Sort – Limit – Skip – Aggregate - Map Reduce. Cursors – Indexes - Mongo Import – Mongo Export. Cassandra: Introduction – Features - Data types – CQLSH - Key spaces - CRUD operations – Collections – Counter – TTL - Alter commands - Import and Export - Querying System tables.

Unit 3

Hadoop Eco systems: Hive – Architecture - data type - File format – HQL – SerDe

- User defined functions - Pig: Features – Anatomy - Pig on Hadoop - Pig Philosophy - Pig Latin overview - Data types - Running pig - Execution modes of Pig - HDFS commands - Relational operators - Eval Functions - Complex data type - Piggy Bank - User defined Functions - Parameter substitution - Diagnostic operator. Jasper Report: Introduction - Connecting to Mongo DB - Connecting to Cassandra - Introduction to Machine learning: Linear Regression – Clustering - Collaborative filtering - Association rule mining - Decision tree.

TEXTBOOK:

Seema Acharya, Subhashini Chellappan, "Big Data and Analytics", Wiley Publication, 2015.

REFERENCES:

1. *Judith Hurwitz, Alan Nugent, Dr. Fern Halper, Marcia Kaufman, "Big Data for Dummies", John Wiley & Sons, Inc., 2013.*
2. *Tom White, "Hadoop: The Definitive Guide", O'Reilly Publications, 2011.*
3. *Kyle Banker, "Mongo DB in Action", Manning Publications Company, 2012.*
4. *Russell Bradberry, Eric Blow, "Practical Cassandra A developers Approach", Pearson Education, 2014.*

15CSE335 BIOINFORMATICS 3 0 0 3

Unit 1

Introduction: The Central Dogma – Killer Application – Parallel Universes – Watson's Definition – Top-Down vs Bottom-Up Approach – Information Flow – Conversance – Communications. Database and Networks: Definition – Data Management – Data Life Cycle – Database Technology – Interfaces – Implementation – Networks: Communication Models – Transmission Technology – Protocols – Bandwidth – Topology – Contents – Security – Ownership – Implementation.

Unit 2

Search Engines and Data Visualization: Search Process – Technologies – Searching and Information Theory – Computational Methods – Knowledge Management – Sequence Visualizations – Structure Visualizations – User Interfaces – Animation vs Simulation. Statistics, Data Mining and Pattern Matching: Statistical Concepts – Micro Arrays – Imperfect Data – Basics – Quantifying – Randomness – Data Analysis – Tools Selection – Alignment – Clustering – Classification – Data Mining Methods – Technology – Infrastructure Pattern Recognition – Discovery.

Unit 3

Machine Learning – Text Mining – Pattern Matching Fundamentals – Dot Matrix Analysis – Substitution Matrix – Dynamic Programming – Word Method – Bayesian Method – Multiple Sequence Alignment Tools. Modelling Simulation and Collaboration: Drug Discovery Fundamentals – Protein Structure – System Biology Tools – Collaboration and Communication – Standards – Issues – Case Study.

TEXTBOOK:

Bergeron B, "Bio Informatics Computing", Prentice Hall, 2003.

REFERENCES:

1. *Affward T K and Smith D J P, "Introduction to Bio Informatics", Pearson Education, 2001.*
2. *Baldi P and Brunak S, "Bio Informatics - The Machine Learning Approach", Second Edition, First East West Press, 2003.*

15CSE336 BIOMETRICS 3 0 0 3

Unit 1

Introduction - Biometric fundamentals – Biometric technologies – Biometrics vs traditional techniques – Characteristics of a good biometric system – Benefits of biometrics – Key biometric processes: verification, identification and biometric matching – Performance measures in biometric systems.

Unit 2

Physiological Biometrics - Leading technologies: Finger-scan – Facial-scan – Iris-scan – Voice-scan – components, working principles, competing technologies, strengths and weaknesses – Other physiological biometrics: Hand-scan, Retina-scan – components, working principles, competing technologies, strengths and weaknesses – Automated fingerprint identification systems. Behavioural Biometrics: Leading technologies: Signature-scan – Keystrokescan – components, working principles, strengths and weaknesses.

Unit 3

Standards in Biometrics - Assessing the Privacy Risks of Biometrics – Designing Privacy - Sympathetic Biometric Systems – Need for standards – different biometric standards - Categorizing biometric applications.

TEXTBOOK:

Anil K Jain, Patrick Flynn, and Arun A Ross, "Handbook of Biometrics", Springer, 2008.

REFERENCES:

1. *Paul Reid, Samir Nanavati, Michael Thieme and Raj Nanavati, "Biometrics – Identity Verification in a Networked World", Wiley-Dream Tech India Private Limited, New Delhi, 2003.*
2. *John R Vacca, "Biometric Technologies and Verification Systems", Elsevier Inc, 2007*

15CSE337 CLOUD COMPUTING AND SERVICES 3 0 0 3

Unit 1

Introduction - Cloud computing at a Glance – Historical Development – Building Cloud Computing Environments – Computing Platform and Technologies – Principles of Parallel and Distributed Computing - Elements of parallel and Distributed Computing.

Unit 2

Virtualization and Cloud Computing Architecture: Introduction - Characteristic of Virtualized Environments – Taxonomy of Virtualization Techniques - Virtualization and Cloud Computing – Technology Examples - Cloud reference model – Types of the Cloud.

Unit 3

Cloud Application Platform and Thread Programming - Anatomy of the Aneka Container – Building Aneka Clouds – Cloud Programming and Management – Programming Applications with Threads – Multithreading and Programming Applications with Aneka Threads, Applications: Amazon Web Applications – Google App Engine – Microsoft Azure – Scientific Applications – Business and Consumer Applications - Third Party Cloud Services.

TEXTBOOK:

Rajkumar Buyya, Christian Vecchiola and Thamari Selvi S, "Mastering in Cloud Computing", McGraw Hill Education (India) Private Limited, 2013.

REFERENCES:

1. *Anthony T Velte, "Cloud Computing: A practical Approach", Tata McGraw Hill, 2009.*
2. *Halper Fern, Kaufman Marcia, Bloor Robin and Hurwit Judith, "Cloud Computing for Dummies", Wiley India, 2009.*
3. *Michael Miller, "Cloud Computing", Pearson Education, New Delhi, 2009.*

15CSE338 COMPUTATIONAL INTELLIGENCE 3 0 0 3

Unit 1

Artificial Intelligence – a brief review – Pitfalls of traditional AI – Why Computational Intelligence? – Computational intelligence concept - Importance of tolerance of imprecision and uncertainty - Constituent techniques – Overview of Artificial Neural Networks, Fuzzy Logic, Evolutionary Computation.

Unit 2

Neural Network: Biological and artificial neuron, neural networks, supervised and unsupervised learning. Single layer Perceptron, Multilayer Perceptron – Back propagation learning. Neural networks as associative memories - Hopfield networks, Bidirectional Associative Memory. Topologically organized neural networks – competitive learning, kohonen maps.

Unit 3

Fuzzy Logic: Fuzzy sets, properties, membership functions, fuzzy operations. Fuzzy logic and fuzzy inference and applications, Evolutionary Computation - constituent algorithms, Swarm intelligence algorithms - Overview of other bio-

inspired algorithms - Hybrid approaches (neural networks, fuzzy logic, genetic algorithms etc.)

TEXTBOOKS:

1. *Kumar S, "Neural Networks - A Classroom Approach", Tata McGraw Hill, 2004.*
2. *Konar. A, "Computational Intelligence: Principles, Techniques and Applications", Springer Verlag, 2005*

REFERENCES:

1. *Engelbrecht, A.P, "Fundamentals of Computational Swarm Intelligence", John Wiley & Sons, 2006.*
2. *Ross T J, "Fuzzy Logic with Engineering Applications", McGraw Hill, 2002.*
3. *Eiben A E and Smith J E, "Introduction to Evolutionary Computing", Second Edition, Springer, Natural Computing Series, 2007.*
4. *Jang J S R and Sun C T, Mizutani E, "Neuro - Fuzzy and Soft Computing", PHI, 2002.*
5. *Rajashekaran S and Vijayalakshmi Pai G A, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 2003.*

15CSE339 COMPUTER SYSTEMS ENGINEERING 3 0 0 3

Unit 1

Introduction to systems - Complexity in computer systems -Abstractions and naming - Modularity with client / server - Operating system structure - Clients and servers within a computer - Virtualizing processors: threads – Performance.

Unit 2

Introduction to networks - Layering and link layer - Network layer, routing - End-to-end layer - Congestion control - Distributed naming - Reliability - Atomicity concepts - Recoverability – Isolation

Unit 3

Multi-site atomicity - Consistency and replication - Security intro - Authentication - Cryptographic protocols - Authorization and confidentiality - Systems design experience – Complexity.

TEXTBOOKS:

1. *Saltzer, Jerome H and Kaashoek M F, "Principles of Computer System Design: An Introduction, Part I", Morgan Kaufmann, 2009.*
2. *Saltzer, Jerome H and Kaashoek M F, "Principles of Computer System Design: An Introduction, Part II", from MIT Open Courseware, 2009.*

REFERENCES:

1. *Brooks and Frederick P Jr, "The Mythical Man-Month", Addison-Wesley, 1995.*

15CSE340 COMPUTER VISION 3 0 0 3

Unit 1

Introduction, Image Formation – geometric primitives and transformations, photometric image formation, digital camera, Image Processing – point operators, linear filtering, neighbourhood operators, fourier transforms, segmentation.

Unit 2

Feature Detection and Matching – points and patches, edges, lines, Feature-based Alignment - 2D, 3D feature-based alignment, pose estimation, Image Stitching, Dense motion estimation – Optical flow - layered motion, parametric motion, Structure from Motion.

Unit 3

Recognition - object detection, face recognition, instance recognition, category recognition, Stereo Correspondence – Epipolar geometry, correspondence, 3D reconstruction.

TEXTBOOK:

Szeliski R, "Computer Vision: Algorithms and Applications", Springer, 2010.

REFERENCES:

1. *Shapiro L G and Stockman G., "Computer Vision", Prentice Hall, 2001.*
2. *Forsyth D A and Ponce J, "Computer Vision – A Modern Approach", Second Edition, Pearson Education, 2012.*
3. *Davies E.R, "Machine Vision: Theory, Algorithms, Practicalities", Morgan Kaufmann, 2004.*
4. *Jain R, Kasturi R and Shunck B G, "Machine Vision", McGraw Hill, 1995.*

15CSE341 CRYPTOGRAPHY 3 0 0 3

Unit 1

Basics of Number theory - Integers and Operations on Integers - Modular arithmetic - Prime Numbers – Primality related properties and Algorithms - Pseudo Random Number Generation. Classical Cryptography: Basic conventions and Terminology - Substitution Ciphers -Transposition ciphers - Rotor machines - Cryptanalysis.

Unit 2

Foundations of Modern Cryptography - Perfect Secrecy - Information and Entropy - Source Coding, Channel Coding, and Cryptography - Product cryptosystems. Symmetric Cryptosystems: Substitution permutation networks DES and Enhancements - AES and its Modes. Asymmetric Key Cryptography: Basic Ideas of Asymmetric Key Cryptography - RSA Cryptosystem.

Unit 3

Primality Testing - Square root modulo m-Factorization Algorithms - Attacks on RSA - Rabin Cryptosystem - Discrete Logarithm Problem and related Algorithms - ElGamal Cryptosystem - Introduction to Elliptic Curve Cryptography - Hash Functions and Message Authentication: Data Integrity - Security of Hash functions - Iterated Hash Functions - Message Authentication.

TEXTBOOK:

Padmanabhan T R, Shyamala C K and Harini N, "Cryptography and Security", First Edition, Wiley Publications, 2011.

REFERENCES:

1. *Stallings W, "Cryptography and Network Security", Third Edition, Pearson Education Asia, Prentice Hall, 2000.*
2. *Forouzan B A, "Cryptography and Network Security", Special Indian Edition, Tata McGraw Hill, 2007*

15CSE342 DATA COMPRESSION 3 0 0 3

Unit 1

Information theoretic foundations: Lossless and lossy compression, Modelling and coding Entropy, conditional entropy, information, channels, Data models: static and adaptive, coding: Fano, Huffman, Golomb, Rice, Tunstall Arithmetic coding: Encoding, Decoding, Adaptation, Dictionary techniques: Static techniques.

Unit 2

Adaptive coding: the LZ family. Context modelling: PPM, Burrows-Wheeler, Move-to front, DMC. Lossless image compression: Multiresolution, CCITT Group 3 and 4, JBIG, JBIG2. Lossy coding preliminaries: Distortion, Rate distortion, linear system models. Scalar and vector quantization: Uniform and non-uniform quantizers, Adaptive quantization, Lloyd-Max quantizer.

Unit 3

Differential encoding: Predictive DPCM, Adaptive DPCM. Transform coding: Bases, inner products, orthogonality and orthonormality, Karhunen-Loéve transform, DCT, Walsh-Hadamard transform, JPEG

TEXTBOOK:

David Salomon and Giovanni Motta, "Handbook of Data Compression", Fifth Edition, Springer, 2010.

REFERENCES:

1. *David Salomon, "Data compression: the complete reference", Third Edition, New York: Springer, 2004.*
2. *Sayood, Khalid, "Introduction to Data Compression", Third Edition, Morgan Kaufmann, 2006.*

15CSE343 DESIGN PATTERNS 3 0 0 3

Unit 1

Introduction to Design Patterns: Significance – Software Design and patterns – Model – View - Controller.

Unit 2

Observer Pattern - Decorator Pattern - Factory Pattern - Singleton Pattern - Command Pattern - Adapter and Facade Patterns - Template

Method Pattern - Iterator and Composite Patterns – The State Pattern – The Proxy Pattern – Compound Patterns.

Unit 3

GRASP Patterns and Anti-patterns. Case Study: Use of patterns in the Design of a Modern Web Framework.

TEXTBOOK:

Erich Freeman, Elisabeth Robson, Bert Bates and Kathy Sierra "Head First Design Patterns", O'Reilly Media Inc., October 2004.

REFERENCES:

1. *Erich Gamma, Richard Helm, Ralph Johnson and John M. Vlissides, "Design Patterns: Elements of Reusable Object Oriented Software", Second Edition, Addison Wesley, 2000*
2. *James W. Cooper, "Java Design Patterns: A Tutorial", Second Edition, Pearson Education, 2003.*
3. *Mark Grand, "Patterns in Java – A Catalog of Reusable Patterns Illustrated with UML", Second Edition, Wiley – Dream tech India, 2002*

15CSE344 DIGITAL WATERMARKING 3 0 0 3

Unit 1

Introduction - Applications and Properties: Applications – Properties – Evaluating watermarking systems, Models of Watermarking: Communication based watermarking – Geometric models of watermarking – Modelling watermarks detection by correlation.

Unit 2

Watermarking with side information: Informed embedding – informed coding – dirty paper codes.

Unit 3

Perceptual Models: Evaluation – Perceptual model – Watson's model – Adaptive watermarking. Robust watermarking – Watermark Security Secret Writing and Steganography – Watermarking for Copyright Protection.

TEXTBOOK:

Ingemar Cox, Matthew Miller, Jeffrey Bloom, Mathew Miller, "Digital Watermarking: Principles and Practice", Morgan Kaufmann Series in Multimedia Information and Systems, 2008.

REFERENCES:

1. *Stefan Katzenbeisser, Fabien A. P. Petitcolas, "Information Hiding Techniques for Steganography and Digital Watermarking", Artech House, 2000.*
2. *Frank Y. Shih, "Digital Watermarking and Steganography: Fundamentals and Techniques", CRC Press, USA, 2007.*
3. *Juergen Seitz, "Digital Watermarking for Digital Media", IGI Global, 2005.*

15CSE345 DISTRIBUTED EMBEDDED SYSTEMS 3 0 0 3

Unit 1

Parallels between the large-scale (Internet-based) and small-scale networked distributed embedded system domains.

Unit 2

Topics in distributed embedded systems: real-time systems, models, communication and scheduling, design and validation, implementation, performance, power and cost, embedded network protocols.

Unit 3

Basics of embedded system security, distributed cyber physical systems that includes integration of protocols, middleware services, and tools into a common architecture with layered, reusable, secure, fault-isolating components, project case studies for distributed embedded systems

TEXTBOOK:

Hermann Kopetz, "Real-Time Systems - Design Principles for Distributed Embedded Applications", Springer, Second Edition, 2011.

REFERENCES:

1. *Phillip Koopman, "Better Embedded Software", Drumnadrochit Education, 2010.*
2. *Steve Heath, "Embedded System Design", Newnes, 2003.*
3. *Peter Marwedel, "Embedded System Design - Embedded System Design Foundations of Cyber - Physical Systems", Springer, Second edition, 2011.*
4. *Wayne Wolf, "Computers as Components", Second edition, Morgan Kaufmann, 2008.*

15CSE346 EMBEDDED PROGRAMMING 2 0 2 3

Unit 1

Basics of Embedded Systems – Definition, Characteristics, Challenges, Embedded Programming Concepts: Role of Infinite loop – Compiling, Linking and locating,

Efficient compilation examples – downloading and debugging – Emulator and simulator processors – External peripherals – Memory testing – Flash Memory.

Unit 2

Operating System: Embedded operating systems – Real time characteristics – Selection process – Flashing the LED – serial ports – code efficiency – Code size – Reducing memory usage – Impact of object oriented programming.

Hardware Fundamentals: Buses – DMA – interrupts – Built-ins on the microprocessor – Conventions used on schematics – Microprocessor Architectures – Software Architectures – RTOS Architectures – Selection of Architecture. RTOS Tasks and Task states – System V IPC mechanisms – Memory management – Interrupt routines – Encapsulating semaphore and queues – Hard Real-time scheduling – Power saving.

Unit 3

Embedded Software Development Tools: Host and target machines – Linkers / Locators for Embedded Software – Debugging techniques – Instruction set simulators Laboratory tools – Practical example – Source code. Case study on Portable computing platforms.

TEXTBOOKS:

1. *Michael Barr, Anthony Massa "Programming Embedded Systems, Second edition With C and GNU Development Tools", O'reilly Media Oct, 2006.*
2. *David E. Simon, "An Embedded Software Primer", Pearson Education, 2003.*
3. *Michael Barr, "Programming Embedded Systems in C and C++", O'Reilly, 2003.*

REFERENCES:

1. *Sriramlyer and Pankaj Gupta, "Embedded Real time Systems Programming", Tata McGraw Hill Publications, First Edition, 2011.*
2. *Raj Kamal, "Embedded Systems: Architecture, Programming and Design", Tata McGraw Hill, 2008.*
3. *Lewis Daniel W, "Fundamentals of Embedded Software: Where C and Assembly Meet", Prentice Hall, 2003.*

15CSE347 ENTERPRISE ARCHITECTURE 3 0 0 3

Unit 1

Enterprise architecture (EA) principles and purpose; modelling approaches for EA definition and communication; key enterprise architecture approaches, standards, and frameworks; best practice for development of enterprise architecture, analysis of alternative models for enterprise architectures; best practice approaches and models for documenting enterprise architectures.

Unit 2

Evaluation of alternative enterprise architecture approaches, identification and evaluation of gaps and opportunities in different enterprise architecture models and processes; models of different aspects of the enterprise architecture processes and artefacts, and architectures at different levels, including conceptual and technical.

Unit 3

Cloud Computing: The internet as a platform, Software as a service and cloud computing, cloud computing platforms, Cloud Technologies – Web Services – SOAP - AJAX, Virtualization and cloud, Mutitenant Software, Data in the cloud and cloud file systems, Big Data: Map Reduce, Hadoop.

TEXTBOOKS:

1. *Scott A. Bernard, and Author house, "An Introduction to Enterprise Architecture", Second Edition, Author House, 2005.*

REFERENCES:

1. *Gautam Shroff "Enterprise Cloud Computing: Technology, Architecture, Applications", Cambridge University Press, 2010.*
2. *Dan C Marinescu, "Cloud Computing: Theory and Practice", Morgan Kaufmann, 2013.*
3. *Sitaram and Manjunath, "Moving to the Cloud", Elsevier, 2012.*
4. *Tom White, "Hadoop: The Definitive Guide", O'Reilly Media, 2012.*

15CSE348 HUMAN COMPUTER INTERFACE 2 0 2 3

Unit 1

Introduction to Interaction Design: User Experience - The process of Interaction Design - Interaction design and User Experience. Understanding and Conceptualizing Interaction: Conceptual Models - Interface Metaphors - Interaction Types - Paradigms and Frameworks. Cognitive Aspects: Cognition - Cognitive Framework. Social Interaction – Emotional Interaction.

Unit 2

Interfaces: Types - Natural User Interfaces, Data Gathering: Key Issues - Data Recording – Interviews – Questionnaires – Observation - Choosing and Combining Technique. Data Analysis, Interpretation and Presentation: Qualitative and Quantitative – Simple Analysis – Tools -Theoretical Frameworks - Presenting the Findings.

Unit 3

Process of Interaction Design: Introduction. Establishing Requirements: Data Gathering for Requirements - Task Description - Task Analysis, Design, Prototyping and Construction: Prototyping and Construction - Conceptual Design and Physical

Design - Using Scenarios, Prototypes in Design. Evaluation: Introduction - Evaluation Framework.

TEXTBOOK:

Sharp, H., Rogers, Y., and Preece, J, "Interaction Design: Beyond Human – Computer Interaction", Third Edition, John Wiley & Sons, Inc., 2011.

REFERENCES:

1. *Alan Dix, Janet E. Finlay, Gregory D. Abowd and Russell Beale, "Human – Computer Interaction", Pearson Education, Third Edition, 2004.*
2. *Wilbert O. Galitz, "The Essential Guide to User Interface Design: An Introduction to Gui Design Principles and Techniques", Third Edition, John Wiley Sons, 2002.*
3. *Benyon, D., Turner, P., and Turner, S, "Designing Interactive Systems: People, Activities, Contexts, and Technologies", Addison-Wesley, 2005.*

15CSE349 INFORMATION CODING TECHNIQUES 3 0 0 3

Unit 1

Source Coding: Information theory, Uncertainty and information, entropy, source coding theorem, Huffman coding, Lempel-Ziv algorithm, Arithmetic coding. Channel capacity and coding: Channel models, channel capacity, channel coding; Information capacity theorem, Shannon limit.

Unit 2

Linear block codes for error correction: Introduction to Error correcting codes, matrix description of linear block codes, equivalent codes, parity check matrix, decoding of linear block code, Syndrome decoding, perfect codes, Hamming codes, Optimal linear codes, MDS codes.

Unit 3

Cyclic Codes: Introduction to cyclic codes, Polynomials, division algorithm for polynomials, method for generating cyclic codes, matrix description, generator polynomial, matrix description Bose-Chaudhuri Hocquenghem (BCH) codes: Introduction to BCH codes, primitive elements, minimal polynomials, generator polynomials, examples Decoding of BCH codes, Reed Solomon codes.

TEXTBOOK:

Ranjan B, "Information Theory, Coding, and Cryptography", Second Edition, Tata McGraw Hill, New Delhi, 2008.

REFERENCE:

Shu Lin, Daniel J. Costello, "Error Control Coding: Fundamentals and Applications", Second Edition, Pearson-prentice Hall, 2004.

15CSE350 INFORMATION RETRIEVAL 3 0 0 3

Unit 1

Boolean Retrieval – The term vocabulary and postings lists – Dictionaries and tolerant retrieval – Index Construction. Index Compression – Scoring, term weighting and the vector space model – Computing Scores in a complete search system – Evaluation in information retrieval.

Unit 2

Relevance feedback and query expansion – XML retrieval – Probabilistic Information retrieval, Text classification and Naive Bayes – Vector space classification – Flat Clustering – Matrix decompositions and latent semantic indexing.

Unit 3

Web search basics – Web crawling and indexes – Link analysis.

TEXTBOOK:

Manning C D, Raghavan P and Schütze H, "Introduction to Information Retrieval", Cambridge University Press, 2008

REFERENCES:

1. *Rijsbergen C J, "Information Retrieval", Second Edition, Butterworths, 1979.*
2. *Grossman D A and Frieder O, "Information Retrieval: Algorithms and Heuristics", Second Edition, Springer, 2004.*
3. *Kowalski G and Maybury M T, "Information Storage and Retrieval Systems", Second Edition, Springer, 2000.*

15CSE351 INFORMATION SECURITY 3 0 0 3

Unit 1

Digital Signature and Authentication Schemes: Digital signature - Digital Signature Schemes and their Variants - Digital Signature Standards - Authentication: Overview - Requirements Protocols - Applications - Kerberos - X.509 Directory Services.

Unit 2

Electronic mail security: Email Architecture - PGP – Operational Descriptions - Key management - Trust Model - S/MIME.IP Security: Overview - Architecture - ESP, AH Protocols IPSec Modes – Security association - Key management.

Unit 3

Web Security: Requirements - Secure Sockets Layer – Objectives - Layers - SSL secure communication - Protocols - Transport Level Security. Secure Electronic Transaction - Entities DS Verification - SET processing.

TEXTBOOK:

Padmanabhan T R, Shyamala C K and Harini N, "Cryptography and Security", First Edition, Wiley India Publications, 2011.

REFERENCES:

1. *Stallings W, "Cryptography and Network Security", Third Edition, Pearson Education Asia. Prentice Hall, 2000.*
2. *Forouzan B A, "Cryptography and Network Security", Special Indian Edition, Tata McGraw Hill, 2007.*

15CSE352 INTELLIGENT SYSTEMS 3 0 0 3

Unit 1

Introduction to agents – Structure of intelligent agents, Problem solving agents – Formulating problems – Overview of uninformed searching strategies, informed search methods, Game playing as search.

Unit 2

Knowledge based agent representation - Logics – First Order logic – Reflex agents – Building a knowledge base – General ontology – Inference – Logical recovery. Planning agents – Planning in situational calculus – Representation of Planning – Partial order Planning – Practical Planners – Conditional Planning.

Unit 3

Agents acting under uncertainty - probability notation - Bayes rule, Probabilistic reasoning - Belief networks – Utility theory - Decision network - Value of information learning agents – Learning from Observations – Knowledge in Learning, Case studies on applications of AI.

TEXTBOOK:

Russell S and Norvig P, "Artificial Intelligence – A modern approach", Third Edition, Prentice Hall, 2009.

REFERENCES:

1. *Elaine Rich, Kevin Knight and Shivashankar B. Nair, "Artificial Intelligence", Third Edition, TMH Educations Private Limited, 2008.*
2. *Nilsson N J, "The Quest for Artificial Intelligence", Cambridge University Press, 2009.*

15CSE353 INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS 3 0 0 3

Unit 1

Introduction to IPR - Overview & Importance, IPR in India and IPR abroad; Patents - their definition, granting, infringement, searching & filing, utility Models an introduction; Copyrights - their definition, granting, infringement, searching & filing, distinction between related and copy rights.

Unit 2

Trademarks - role in commerce, importance, protection, registration, domain names; Industrial Designs - Design Patents, scope, protection, filing infringement, difference between Designs & Patents.

Unit 3

Geographical indications, international protection; Plant varieties; breeder's rights, protection; biotechnology & research and rights managements; licensing, commercialisation; legal issues, enforcement; Case studies in IPR.

TEXTBOOK:

James Boyle and Jennifer Jenkins, "Intellectual Property Law and the Information Society", Published by Duke University, 2014.

15CSE355 MODELLING AND SIMULATION 3 0 0 3

Unit 1

Principle of computer modeling and simulation, Monte Carlo simulation. Nature of computer modelling and simulation. Limitations of simulation, areas of application. System and environment – components of a system – Discrete and continuous systems. Models of a system – A variety of modelling approaches.

Unit 2

Random number generation, technique for generating random numbers – Midsquare method – The midproduct method – Constant multiplier technique – Additive congruential method – Linear congruencies method – Tests for random number – The Kolmogorov Smirnov test – The chi-square test. Random variable generation – Inverse transform technique – Exponential distribution – Uniform distribution – Weibull distribution, empirical continuous distribution – Generating approximate normal variates. Empirical discrete distribution – Discrete uniform distribution – Poisson distribution – Geometric distribution – Acceptance – Rejection technique for Poisson distribution – Gamma distribution.

Unit 3

Design and evaluation of simulation experiments – Input – Output analysis – Variance reduction technique – Verification and validation of simulation models. Discrete event simulation – Concepts in discrete – event simulation – Manual simulation using event scheduling, single channel queue, two server queue, simulation of inventory problems. Simulation languages – GPSS – SIMSCRIPT – SIMULA – Programming for discrete event systems in GPSS and C. Case Study: Simulation of LAN – Manufacturing system – Hospital management system.

REFERENCES:

1. *Jerry Banks and John S. Carson, "Discrete Event System Simulation", Fifth Edition, Prentice Hall Inc, 2009.*
2. *Narsingh Deo, "System Simulation with Digital Computer", Prentice Hall of India, 1979.*
3. *Francis Neelamkovil, "Computer Simulation and Modeling", John Wiley & Sons, 1987.*
4. *Averil M. Law and W. David Kelton, "Simulation Modeling and Analysis", McGraw Hill International Editions, 1991.*

15CSE356 MULTIMEDIA DATABASES 2 0 2 3

Unit 1

Introduction: An introduction to Multimedia Databases – Need for MMDB – Metadata based and Content based Retrieval. Object Oriented and Object Relational Databases: Object Relational Database – Object-Oriented Databases – Data Models – Queries over such databases.

Unit 2

Architectures for MMDB: Architecture requirements - multimedia server design - distributed multimedia servers - client server architecture - peer-to-peer systems Metadata for MMDB: Features of Metadata - Types of Metadata - Metadata for Text, Images, Audio, Video - Annotation, generation and extraction – standards Multimedia Query Processing: Data Manipulation - Transaction Management – Query Processing - Query language issues - SQL for Multimedia Queries. Storage Management: Access Methods and Indexing - Quad tree – R-Trees Storage Methods (Striping, RAID etc).

Unit 3

Image Databases: Overview - Representing Image DB with Relations and R-Trees - Overview of Image Retrieval and Mining - Similarity Based Retrieval - Metric Approach Text Databases: Overview – Processing and Indexing Text Data - Inverted indices - overview of text retrieval / mining - Boolean Retrieval – Vector based Retrieval – Semantic Retrieval. Video Databases: Organizing content of a single video - overview of video and audio mining - query languages for videos - indexing video content – r-segment trees Multimedia DB: Mining combinations of data, architectures (only high level overview), Performance issues – Visualization of Multimedia Data.

TEXTBOOK:

Subhramanian V S, "Principles of Multimedia Database Systems", Morgan Kaufmann Publisher, 2001.

REFERENCES:

1. *Lynne Dunckley, "Multimedia Databases: An Object - Relational Approach", Pearson Education, 2003.*
2. *Khoshafian, "Multimedia and Imaging Databases", Lavoisier Publications, 1997.*

3. *Bhavani Thurasingham, "Managing and Mining Multimedia Databases", CRC Press, 2001.*
4. *J. K. Wu, M. S. Kankanhalli, J. H. Lim and D. Z. Hong, "Perspectives on Content based Multimedia Systems", Kluwer Academic Publishers, 2000.*

15CSE357 NAND2TETRIS: BUILDING COMPUTERS FROM FIRST PRINCIPLES 2 0 2 3

Unit 1

Hello World Below: Abstraction, Implementation Paradigm – HDL Overview – Implementing Gates in HDL – Combinational Logic: Design and Implement Binary Adders – Simple ALU Construction – Sequential Logic: Design and Implementation of Memory Hierarchy – Implementing Flip Flop Gates, Registers and RAM units of Arbitrary Sizes – Machine Language: Instruction Set (Binary and Assembly Versions) – Writing Low-level Assembly Programs – Running on CPU Emulator.

Unit 2

Computer Architecture: Integrating Chip-sets – Building an Assembler – Virtual Machine I: Implementing a VM to translate from VM language into assembly language – Virtual Machine II: Complete VM implementation as the back-end component of Compiler.

Unit 3

High Level Language: Introduction to Jack a high-level object-based language – Compiler I: Building a Syntax analyzer for Jack – Compiler II: Morphing syntax analyzer into a full-scale compiler – Operating System: Design and Implementation of some classical arithmetic and geometric algorithms needed for OS implementation.

TEXTBOOK:

Noam Nisan and Shimon Schocken, "The Elements of Computing Systems – Building Modern Computers from First Principles", MIT Press, 2008.

REFERENCES:

3. *Edward G. Amoroso and Matthew E. Amoroso, "From Gates to Apps", Silicon Press, 2013.*
4. *Roger Young, "How Computers Work: Processor and Main Memory", Create space Independent Publishing Platform, Second Edition, 2009.*
5. *Charles Petzold, "Code: The Hidden Language of Hardware and Software", Microsoft Press, 2000.*

15CSE358 NATURAL LANGUAGE PROCESSING 3 0 0 3

Unit 1

Introduction: Words – Morphology and Finite State transducers - Computational Phonology and Pronunciation Modelling - Probabilistic models of pronunciation and spelling – Ngram Models of syntax - Hidden markov models and Speech recognition - Word classes and Part of Speech Tagging.

Unit 2

Context free Grammars for English – Parsing with Context free Grammar – Features and unification - Lexicalized and Probabilistic Parsing -Language and Complexity. Semantics: Representing meaning - Semantic analysis - Lexical semantics - Word sense disambiguation and Information retrieval.

Unit 3

Pragmatics: Discourse - Dialog and Conversational agents - Natural language generation, Statistical alignment and Machine translation: Text alignment – word alignment – statistical machine translation.

TEXTBOOK:

Daniel and Martin J H, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Prentice Hall, 2009.

REFERENCES:

1. *Manning C D and Schutze H, "Foundations of Statistical Natural Language processing", First Edition, MIT Press, 1999.*
2. *Allen J, "Natural Language Understanding", Second Edition, Pearson Education, 2003.*

15CSE359 OS FOR SMART DEVICES (ANDROID AND IOS) 2 0 2 3

Unit 1

iOS: Top down view of iOS – System Start-up Procedure iBoot – Processes - Threads – virtual memory - File Systems – Security Architecture - Internal API used by the system - BSD and Mach- Dissecting the kernel, XNU, into its sub components: Mach, the BSD Layer, and I/o kit - Inner workings of device drivers. Objective C – Swift Programming - Xcode, Cocoa Touch API, memory management, user input and gesture recognition, data persistence including Core Data, SQLite, NSUser Defaults and Plists. Working with audio, video and the accelerometer. Simple Applications development.

Unit 2

Android: Introduction - Introduction to the Linux kernel - Compiling and booting the Linux kernel - Understanding the Android Internals - Understanding the Android Build System - Customizing Android for a specific hardware - Building and booting Android.

Android changes to the Linux kernel - Android boot-loaders - Booting Android - Using ADB - Android file-system. Android build system - Adding a new module and product. Android native layer - Bionic, Toolbox, init, various daemons, Dalvik, hardware abstraction, JNI

Unit 3

Android framework for applications - Introduction to application development - Android packages - Advice and resources -Application ecosystem - web technologies in Mobile OS - Hardware accelerated graphics through OpenGL ES - ANDROID support for all the common wireless mechanisms: GSM, CDMA, UMTS, LTE, Bluetooth, WiFi, NFC.

Case Study: Extending the Android framework for ARM-based hardware.

TEXTBOOKS:

1. *Jonathan Levin, "MAC OS X and iOS internals: to the Apple's Core", Wiley / Wrox Tile, 2012.*
2. *Ole Henry Halvorsen and Douglas Clarke, "OS X and iOS Kernel Programming", First Edition, Apress Publication, 2011.*

REFERENCES:

1. *Karim Yaghmour, "Embedded Android: Porting, Extending and Customizing", O'Reily Publications, 2013.*
2. *Earlence Fernandes, "Instant Android Systems Development How To", PACKT Publishing, 2013.*

15CSE360 PARALLEL AND DISTRIBUTED COMPUTING 3 0 0 3

Unit 1

Introduction: The Reality of High Performance Computing - Modern Algorithms – Compilers - Scientific Algorithms – History - State-of-Art and Perspective - Things that are not Traditional Supercomputers. Parallel Computing - PDC models working mechanism - scalability of PDC architectures – applications, performance metrics and Amdahl's Law.

Unit 2

Models and Algorithms - PRAM algorithms, Process-level parallelism, data-level parallelism, Problem partitioning, divide-and-conquer, Distributed algorithms – Algorithm design techniques - filters, client / server, heartbeat, probe / echo, token passing, replicated servers Communication - Interconnection network design, Topological and parametric models of interconnection networks; routing mechanisms; flow control mechanisms, communication protocols, Communication primitives - Point-to-point communication primitives; group communication patterns; broadcast in distributed systems, CSP, MPI; Synchronization - Locks, monitors, barriers; deadlock; hardware primitives and implementation issues; clock synchronization, distributed mutual exclusion; distribute deadlock detection.

Unit 3

Computation: Threads - Creation, coordination, termination; futures. Shared Memory

- Models of memory consistency; implementation of consistency protocols; transactions: serializability, concurrency - control, commit protocols; Linda. Scheduling and Load Balancing: Load distribution algorithms; task migration; co-scheduling; affinity scheduling; self-scheduling in loops.

TEXTBOOK:

Wilkinson B and Allen M, "Parallel Programming Techniques and Applications using Networked Workstations and Parallel Computer", Second Edition, Prentice Hall, Upper Saddle River,2004.

REFERENCES:

1. *Tanenbaum A, "Distributed Operating Systems", Prentice Hall, 1999*
2. *Nikhil R S and Arvind, "Implicit Parallel Programming in PH", Morgan Kaufman, 2001.*

15CSE361 PATTERN RECOGNITION 3 0 0 3

Unit 1

Introduction: Machine perception – Pattern recognition systems – Design cycle – Learning and adaptation - Bayesian decision theory - minimum error rate classification – discriminant functions – decision surfaces – normal density based discriminant functions - Maximum likelihood estimation – Bayesian estimation.

Unit 2

Bayesian parameter estimation – Gaussian case – problems of dimensionality - Components analysis and discriminants – hidden Markov models, Non-parametric Techniques: density estimation – parzen windows – nearest neighbourhood estimation – linear discriminant functions and decision surfaces – two category linearly separable case – perception criterion function.

Unit 3

Non-Metric Methods: decision trees – CART methods – algorithm independent machine learning- bias and variance – regression and classification - classifiers – Unsupervised learning and clustering – mixture densities and identifiably – hierarchical clustering – low dimensional representation – multidimensional scaling.

TEXTBOOK:

Duda R O, Hart P E and Stork D G, "Pattern Classification", Second Edition, John Wiley & Sons, 2003.

REFERENCES:

1. *Gose E, Johnsonbaugh R and Jost S, "Pattern Recognition and Image Analysis", Prentice Hall of India, 2002.*
2. *Bishop C M, "Pattern Recognition and Machine Learning (Information Science and Statistics)", First Edition, Springer, 2006.*
3. *Bishop C M, "Neural networks for Pattern Recognition", Oxford University Press, 1995.*

15CSE362 PERVASIVE COMPUTING 3 0 0 3

Unit 1

Basics: Some Computer Science Issues in Ubiquitous Computing, Pervasive Computing:

Vision and Challenges, Naming and Service Discovery: The Design and Implementation of an Intentional Naming System, Dealing with Location: Providing Location Information in a Ubiquitous Computing Environment, The Cricket Compass for Context-Aware Mobile Applications, Mobile Data Access: Balancing Push and Pull for Data Broadcast, Rover: A Toolkit for Mobile Information Access, Agile Application - Aware Adaptation for Mobile Computing, the Roma Personal Metadata Service, Consistency Management.

Unit 2

Mobile Networking: Scalable Support for Transparent Host Internetworking, A Comparison of Mechanisms for Improving TCP Performance over Wireless Networks, An End-to-End Approach to Host Mobility, Reliable Network Connections Distributed File Systems: Exploiting Weak Connectivity for Mobile File Access, Automated Hoarding for Mobile Computers, Personal RAID: Mobile Storage for Distributed and Disconnected Computers Energy Management.

Unit 3

Sensor Networks: Mobile Networking for "Smart Dust", Building Efficient Wireless Sensor Networks with Low-Level Naming, Fine-Grained Network Time Synchronization using Reference Broadcasts Security: The Resurrecting Duckling: Security Issues for Ad-Hoc Wireless Networks, Zero-Interaction Authentication, SPINS: Security Protocols for Sensor Networks, Toward Speech-Generated Cryptographic Keys on Resource-Constrained Devices.

TEXTBOOK:

Jochen Burkhardt, Dr Horst Henn, Stefan Hepper, Klaus Rindtorff and Thomas Schaeck, "Pervasive Computing: Technology and Architecture of Mobile Internet Applications", Addison Wesley Publisher, 2002.

REFERENCE:

Sumi Helal, "The Landscape of Pervasive Computing Standards", Morgan and Claypool Publishers, 2010.

15CSE363 PRINCIPLES OF DIGITAL IMAGE PROCESSING 3 0 0 3

Unit 1

Mathematical Background for Image Processing: Review of Vectors and Matrices - Review of Probability and statistics. Digital Image Fundamentals: Elements of

Visual Perception - Image Sensing and Acquisition – Image Sampling and Quantization – Basic Relationships between Pixels - Image interpolation. Intensity Transformations and Spatial Filtering: Basic Intensity transformation Functions – Histogram Processing – Fundamentals of Spatial Filtering – Smoothing and Sharpening Spatial Filters.

Unit 2

Filtering in Frequency Domain: 2D Discrete Fourier Transforms - Basics of filtering - Image Smoothing and Image Sharpening Using Frequency Domain Filters - Selective Filtering, Image Restoration: Noise Models – Restoration using Spatial Filters – Periodic Noise Reduction by Frequency Domain Filters.

Unit 3

Morphological Image Processing: Erosion – Dilation – Opening – Closing – Hit-or-Miss Transform - Extraction of Connected Components. Image Segmentation: Fundamentals – Point, Line and Edge Detection – Thresholding - Region Based Segmentation – Region Growing – Region Splitting and Merging. Color image processing.

TEXTBOOK:

Gonzalez R C and Woods R E, "Digital Image Processing", Third Edition, Pearson Education, 2009.

REFERENCES:

1. *Pratt W K, "Digital Image Processing", Fourth Edition, John Wiley & Sons, 2007.*
2. *Castleman K R, "Digital Image Processing", Prentice Hall, 1996.*
3. *Gonzalez, Woods and Eddins, "Digital Image Processing Using MATLAB", Prentice Hall, 2004.*
4. *Russ J C, "The Image Processing Handbook", CRC Press, 2007.*

15CSE364 REAL–TIME COMPUTING SYSTEMS 3 0 0 3

Unit 1

Basic Real-Time Concepts: Terminology – Real-Time system design issues – Example Real-time systems Hardware Considerations: Basic architecture – Hardware interfacing - Central Processing Unit – Memory – Input / Output – Enhancing performance Real-Time Operating Systems: Real-Time kernels – Theoretical foundations of real-time operating systems – Intertask communication and synchronization – Memory management.

Unit 2

Software Requirements Engineering: Requirements engineering process – Types of requirements – Requirements specification for Real-time systems – Formal methods in software specification – Structured analysis and design – Object oriented analysis and the Unified Modelling Language (UML) Software System Design: Properties of software – Basic software engineering principles – The design activity – Procedural oriented design – Object oriented design.

Unit 3

Performance Analysis and Optimization: Theoretical Preliminaries – Performance Analysis – Application of Queuing theory – I/O performance – Performance Optimization – Results from compiler optimization – Analysis of memory requirements – Reducing memory utilization.

TEXTBOOK:

Laplante P A, "Real-Time Systems Design and Analysis", Third Edition, Wiley-India,2005.

REFERENCES:

1. *Williams R, "Real-Time Systems Development", Elsevier, 2006.*
2. *Liu J W S, "Real-Time Systems", Prentice Hall, 2000.*

15CSE365 SCIENTIFIC COMPUTING 3 0 0 3

Unit 1

Systems of Linear Algebraic equations: Introduction, Gauss Elimination Method, LU decomposition, Symmetric and banned coefficient Matrices, Pivoting, Matrix Inversion, Iterative Methods, Other methods.

Unit 2

Interpolation and Curve Fitting: Polynomial Interpolation, Least square fit, Other methods; Roots of equations: Search Methods, Method of Bisection, Roots of Equations, Brent's method, Newton Raphson Method, Systems of Equations, Zeros of Polynomials

Unit 3

Numerical Differentiation: Finite Difference approximations; Numerical Integration; Initial Value Problems; Two-Point Boundary Value Problems; Symmetric Matrix Eigen value problems; Introduction to Optimization.

TEXTBOOK:

Jaan Kiusalaas, "Numerical Methods in Engineering with Python", Cambridge University Press, 2005.

15CSE366 SEMANTIC WEB 3 0 0 3

Unit 1

The semantic web vision - introduction to semantic web technologies - a layered approach, Describing web resources - RDF data model, RDF syntax, RDF Schema, Querying the semantic web - SPARQL infrastructure, matching patterns, Filters, organizing the results, querying the schema, adding information with SPARQL update.

Unit 2

Web ontology Language - introduction, requirement of ontology languages, the OWL language, Logics and Inferences - Monotonic rules and semantics, OWL2 RL, rules inference format, SWRL, SPIN, Rule ML.

Unit 3

Ontology Engineering - Constructing ontologies manually, Reusing existing ontologies, Semiautomatic ontology acquisition, ontology mapping, semantic web applications architecture, Applications - BBC artists, BBC world Cup 2010 website, government data, schema.org.

TEXTBOOK:

Paul Groth, Frank van Harmelen, Rinke Hoekstra, "A Semantic Web Primer", Third edition, MIT Press, 2012

REFERENCES:

1. *Pascal Hitzler, Markus Krotzsch, Sebastian Rudolph, "Foundations of Semantic Web Technologies", CRC Press, 2009.*
2. *Karin Breitman, Marco Antonio Casanova, Walt Truszkowski, "Semantic Web: Concepts, Technologies and Applications", Springer Science &Business Media, 2007.*

15CSE367 SERVICE-ORIENTED ARCHITECTURE 3 0 0 3

Unit 1

SOA Fundamentals - Defining SOA - Business Value of SOA – Architecture - Infrastructure Services Web Services Technologies: Web Services & SOA - WSDL, SOAP – UDDI – WS-Transaction, WS-Security - WS-Reliable Messaging. WS-Policy - WS-Attachments.

Unit 2

BPEL for Web Services SOA Planning and Analysis - Lifecycle - Capturing Business IT Issues - Determining Non-Functional Requirements - Enterprise Solution Assets - Tools Available for Appropriate Designing - Implementing SOA. SOA Platform Basics: SOA Support in J2EE, JAX-WS, JAXB, JAXR, JAX-RPC, WSIT, SOA support in .NET, ASP.NET web services.

Unit 3

Introduction to Cloud Computing - Cloud Computing (NIST Model) Properties - Service Models (XaaS), The Google File System - Virtualization Techniques in Cloud - Parallelization in Cloud - Privacy in Cloud - Data Processing in Large Clusters. Google's Map Reduce Programming Model.

TEXTBOOK:

1. *Thomas Erl, "Service Oriented Architecture, Concepts, Technology and Design", Prentice Hall of India, 2005.*

REFERENCES:

1. *Norbert Bieberstein, Sanjay Bose, Marc Fiammente, Keith Jones and Rawn Shah, "Service Oriented Architecture Compass: Business Value, Planning and Enterprise Roadmap", Second Edition, IBM Press, 2005.*
2. *Sandy carter, "The New Language of Business: SOA and Web 2.0", IBM press, 2007.*
3. *Thomas Erl, "Service Oriented Architecture: A Field Guide to Integrating XML and Web Services", First Edition, Prentice Hall, 2004.*
4. *Toby Velte, Anthony Velte and Robert Elsen Peter, "Cloud Computing A Practical Approach", First Edition, Tata McGraw-Hill,2009.*

15CSE368 SOFTWARE QUALITY ASSURANCE 3 0 0 3

Unit 1

Introduction - Software Quality in the Business Context - Managing Software Quality in the Organization - Quality Management Systems - Planning for Software Quality Assurance - Product Quality and Process Quality.

Unit 2

Software Measurement and Metrics - Walkthroughs and Inspections - ISO 9001 - What is ISO 9001 - What CMMI - Introduction to CMMI is for development - Process Area Components - Understanding Capability Levels - Introduction to People CMM.

Unit 3

Statistical Quality Control and Process Control - Software Maintenance Models - Cyclomatic Complexity - Principles of Coupling and Cohesion - Introduction to Six Sigma, Case Studies - Indian Software Industry in perspective.

TEXTBOOK:

Godbole N, "Software Quality Assurance, Principles and Practice", Narosa Publications, 2011.

REFERENCES:

1. *CMMI Product Team. CMMI for Development, Version 1.3(CMU/SEI-2010-TR-033). Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University, November 2010. http://www.sei.cmu.edu/library/abstracts/reports/10tr033.cfm.*
2. *Bill Curtis, William Hefley and Sally A. Miller, "The People CMM: A Framework for Human Capital Management", Second Edition, Addison-Wesley, 2009.*
3. *Perry W, "Effective Methods of Software Testing", Third Edition, Wiley Publication, 2007.*
4. *Pankaj Jalote, "An Integrated Approach to Software Engineering", Third Edition, Springer, 2006.*
5. *Bill Curtis, William E. H, Sally A. M, "People CMM: A Framework for Human Capital Management", Second Edition, Pearson Education, 2009.*

15CSE369 SPATIOTEMPORAL DATA MANAGEMENT 3 0 0 3

Unit 1

Introduction to Spatial Databases: Requirements, Principles, and Concepts for Spatial Database Management Systems (SDBMS) - Spatial Databases and Geographic Information Systems SDBMS and GIS Applications.

Unit 2

Models for Spatial Data: Geographic Space Modelling - Representation Models - Geometry of Collection of Objects - Vector Data - Raster Data - Modelling Spatial Data. Spatial Access Methods (SAM): Issues in SAM Design - Space Driven Structures versus Data Driven Structures - The Grid File – Quadtree and Variants - R-Tree and Variants - k-d-B Tree - Other common and useful SAM - Cost Models.

Unit 3

Query Processing: Algebras and Query Languages for Spatial Data - Spatial Join Queries - Nearest Neighbour Queries - Queries over Raster Data (Map Algebra) - Cost Models. Spatio-Temporal Databases: Introduction to Temporal Databases - Specialized Index Structures - Query Processing. Spatial DBMS and GIS - GRASS – Post GIS, Advanced Topics: Geographic Data Mining - Streaming (remotely-sensed) Data - Mobile Objects and Location Aware Services.

TEXTBOOK:

Philippe Rigaux, Michel Scholl, Agnes Voisard, "Spatial Databases with Applications to GIS", Morgan Kaufman, 2002.

REFERENCES:

1. *Shashi Shekhar, Sanjay Chawla, "Spatial Databases: A Tour", Prentice Hall, 2003.*
2. *H. Samet, "Foundations of Multidimensional and Metric Data Structures", Morgan-Kaufmann, 2006.*

15CSE370 WIRELESS AND MOBILE COMMUNICATION 3 0 0 3

Unit 1

Introduction to wireless communications: Evolution of mobile radio communications, paging system, cordless telephone system, cellular telephone system, Modern wireless communication systems: 2G networks, 3G networks, Bluetooth and personal area networks.

Unit 2

Mobile radio propagation: large scale path loss - Free space propagation model, basic propagation mechanisms. Digital Cellular Transmission, Spread Spectrum Transmissions Local Area & Ad Hoc Networks: LAN Technologies: Evolution of

Wireless LAN, IEEE802.11, Physical, Layer, MAC Sub-layer, routing algorithms. Adhoc networks: Characteristics – Performance issues. Overview to Wireless ATM, HYPERLAN, IEEE802.15 Wireless PAN, and Home RF.

Unit 3

Bluetooth Cellular concepts: Frequency reuse, channel assignment strategies, hand off strategies, interference and system capacity, improving coverage and capacity in cellular systems, routing in mobile hosts. Mobile IP – DHCP - Mobile transport layer – Indirect TCP - Snooping TCP - Transmission / time-out freezing – Selective retransmission –Transaction oriented TCP.

TEXTBOOK:

Rappaport T S, "Wireless Communication: Principles and Practice", Second Edition, Pearson Education, 2009.

REFERENCES:

1. *Pahlavan K and Krishnamurthy P, "Principles of Wireless Networks", Prentice–Hall, 2006.*
2. *Stallings W, "Wireless communications and networks", Pearson Education Limited, 2002.*
3. *Jochen S, "Mobile communications", Pearson Education Limited, 2000.*
4. *Lee W C Y, "Wireless and Cellular Communications", Third Edition, Tata McGraw Hill Publishing Company Limited, 2006.*

15CSE371 WIRELESS AND MOBILE COMPUTING 3 0 0 3

Unit 1

Wireless Networks – basic routing protocols -– power saving techniques - Disruption tolerant networks – routing - Mobility Service Architecture, Mobility Environment Architecture, Mobile Computing Devices and Features, Design Issues, data types - Challenges in Mobile Computing Adaptive Application in Mobile Environment: Adaptability and Adaption, Adaptability Issues, Mobility Management, Handoff, Location Management Principles and Techniques, Registration Area–Based Location Management, Forwarding Pointers, PCS Location Management Scheme, Energy Efficient Network Protocols, Routing Protocols, Mobile IP, Energy Efficient Indexing.

Unit 2

Data Dissemination and Management: Issues Facing Data Dissemination in a Mobile Environment, Bandwidth Allocation for Publishing, Broadcast Disk Scheduling, Push-based Data Scheduling, On-demand Data Scheduling, Hybrid Data Scheduling, Caching Management in Mobile, Characteristics of Mobile Cache, Cache Management Schemes, Mobile Web Caching, social aware data forwarding – data dissemination, urban sensing.

Mobile Middleware – Challenges - Categories - Characteristics, Traditional Middleware Applied in Mobile Computing, Mobile Agents, Mobile Agent Architecture, Mobile Agent Security and Fault Tolerance using Distributed Transactions, Reliable Agent Transfer, Architecture of a Secure Agent System, Network Security Testing using Mobile Agents.

Unit 3

Programming Mobile Devices: Motivation and Programming Strategies - Memory Management - Energy and resource management - Power-aware Computing: Power management – Operating System level Power management – Power-aware real-time system. Design Patterns for Limited Memory, Memory Management in Mobile Java, Memory Management in Android OS Applications - Workflow for Application Development, Techniques for Composing Applications, Application Models in Mobile Java, Case study: Android OS Application Infrastructure – Advanced Telecommunications Computing Architecture. Cluster computing - Grid computing - Virtualisation and Cloud Computing - mobile cloud – Activity recognition – crowd sourcing – security and privacy issues.

TEXTBOOK:

Stojmenovic and Cacute, "Handbook of Wireless Networks and Mobile Computing", Wiley, 2002.

REFERENCES:

1. *Prasant Kumar Pattnaik, Rajib Mall, "Fundamentals of Mobile Computing", PHI Learning 2012.*
2. *Uhler, David, Mehta, Khanjan, "Mobile Computing, Applications, and Services", Fourth International Conference, MobiCASE 2012, Springer, Seattle, WA, USA, October 2012.*
3. *Adelstein, Frank, Gupta, Sandeep KS, Richard III, Golden, Schwiebert, Loren, "Fundamentals of Mobile and Pervasive Computing", McGraw-Hill Professional, 2005.*

15CSE372 WIRELESS SENSOR NETWORKS 3 0 0 3

Unit 1

Overview of WSN: Introduction, Sensor network applications – Habitat Monitoring –Tracking chemical plumes - Smart transportation. Constraints and Challenges, Emerging technologies for wireless sensor networks - Advantages of sensor networks.

Unit 2

Architectures: Hardware components – sensor node overview – controller- memory – communication device - sensors and actuators – power supply of sensor nodes – Network architecture – Sensor network scenarios – types of sources and sinks – single hop Vsmulti hop - multiple sources and sinks – mobility - Gateway Concepts.

Unit 3

Protocols: MAC Protocols for Wireless Sensor Networks - Low duty cycle protocol: SMAC - Contention Based Protocol: CSMA, Scheduling Based Protocol – Routing Protocol: AODV, DSDV, optimized Linked State Routing, DSR and Reactive routing: Flooding, Hierarchical routing, Location based Routing - Unicast and Multicast.

TEXTBOOK:

Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005.

REFERENCES:

1. *Feng Zhao and Leonidas J. Guibas, "Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.*
2. *Kazem Sohraby, Daniel Minoli, and Taieb Znati, "Wireless Sensor Networks -Technology, Protocols and Applications", John Wiley, 2007.*
3. *Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003.*

15CSE374 INTRODUCTION TO DATA STRUCTURES AND ALGORITHMS 3 0 0 3

Unit 1

Introduction: Overview of Data Structures – A Philosophy of Data Structures - The Need for Data Structures – Cost and Benefits - Abstract Data Types and Data Structures - Principles, and Patterns. Basic complexity analysis – Best, Worst, and Average Cases - Asymptotic Analysis - Analyzing Programs – Space Bounds, Arrays, Linked Lists and Recursion: Using Arrays - Lists - Array based List Implementation – Linked Lists – LL ADT – Singly Linked List – Doubly Linked List – Circular Linked List - recursion - linear, binary, and multiple recursions.

Unit 2

Stacks and Queues: Stack ADT - Array based Stacks, Linked Stacks – Implementing Recursion using Stacks, Queues - ADT, Array based Queue, Linked Queue, Double-ended queue, Circular queue. Trees: Tree Definition and Properties – Tree ADT - Basic tree traversals - Binary tree - Data structure for representing trees – Linked Structure for Binary Tree – Array based implementation. Priority queues: ADT – Implementing Priority Queue using List – Heaps. Maps and Dictionaries: Map ADT – List based Implementation – Hash Tables - Dictionary ADT - Skip List – Complexity.

Unit 3

Search trees – Binary search tree, AVL tree, Trees – K-D Trees - B-Trees. Sorting and Selection – Linear Sorting – Heap Sort - Divide and Conquer Strategy – Analysis using Recurrence Tree based Method - Merge Sort - Quick Sort - Studying Sorting through an Algorithmic Lens – Selection.

TEXTBOOKS:

1. *Goodrich M T and Tamassia R, "Data Structures and Algorithms in Java", Fifth edition, Wiley publication, 2010.*
2. *Clifford A. Shaffer, "Data Structures and Algorithm Analysis", Third Edition, Dover Publications, 2012.*

REFERENCES:

1. *Goodrich M T, Tamassia R and Michael H. Goldwasser, "Data Structures and Algorithms in Python++", Wiley publication, 2013.*
2. *Tremblay J P and Sorenson P G, "An Introduction to Data Structures with Applications", Second Edition, Tata McGraw-Hill, 2002.*

15CSE376 NET CENTRIC PROGRAMMING 2 0 2 3

Unit 1

Introduction to Internet: The domain name system – Client / Server model – Internet Services of the Internet – Ports – IP addresses – Web architecture – Parsing in Browsers – Web site design standards. Client Side Technologies: Introduction to Markup languages (SGML, HTML, DHTML) – Introduction to scripting languages (Javascript, VBScript, PHP). XML: Comparison with HTML - DTD - XML Elements - Content Creation - Attributes - Entities - XSL - XLINK - XPATH - XPOINTER - Namespaces - Applications - Integrating XML with other applications.

Unit 2

J2EE: Architecture - Servlets, Java Server Pages – Java Beans – Building EJB applications.

Unit 3

Middleware Architecture: CORBA, MULE, ACTIVE MQ.

TEXTBOOKS:

1. *Bates C, "Web Programming - Building Internet Application", Second Edition, Wiley-Dreamtech India Pvt. Ltd., 2002.*
2. *Pitter K, Amato S and Callahan J et al, "Every students guide to the Internet", Tata McGraw Hill, 2005.*
3. *Aaron W E, "J2EE a Professional Guide", Tata McGraw Hill, 2003.*

15CSE381 COMPUTER ORGANIZATION AND ARCHITECTURE LAB. 0 0 2 1

Familiarization with a MIPS Simulator SPIM (PCSPIM – a PC version of SPIM will be used) - MIPS assembly program that inputs two integers from the user and displays their sum - MIPS assembly program that asks user to enter an integer n and displays

nth Fibonacci number - Test your programs using SPIM simulator - MIPS assembly program that asks user to enter an integer n and displays its factorial. Implementation of pipeline concepts and exploring its operations - Implementation of vector operations in MIPS Assembly and exploring Loop Unrolling. Design of single instruction CPU Design of a simple Memory Unit CPU using simulator. Design of ALU with at-least 8 operations. Design of simple memory with m number of address lines and n number of data lines. Design of Associative / Direct Mapped Cache memory design.

15CSE385 COMPILER DESIGN LAB. 0 0 2 1

Tokenizing using DFA - Design of Lexical Analyzer (Tools: Jlex / JFlex / Lex) – Design of Parser (Tools: YACC / CUP / Bison / ANTLR): Recursive Descent Parser, LL/LR Parser - Creation of Abstract Syntax Tree (Tools: YACC / CUP / Bison / ANTLR) - Creation of Symbol tables - Semantic Analysis - Generation of Intermediate Code.

15CSE386 COMPUTER NETWORKS LAB. 0 0 2 1

Client server communication using basic socket communication (TCP and UDP- one way and Two way communication). Experimental study of Application Protocols using HTTP, FTP, SMTP, using Network packet sniffers and analyzers such as Ethereal – Exercises in Socket Programming in C / C++ / Java. Implementation of unicast, broadcast and multicast Communication. Packet Sniffers for understanding the TCP Protocol – File Transfer between nodes in a Network – CSMA / CD - Introduction to ns2 (Network Simulator) – Small Simulation exercises to study TCP Behaviour under different scenarios. Setting up a small IP network - Configure interfaces, IP addresses and routing Protocols to set up a small IP network. Study dynamic behavior using packet sniffers – Design and Implementation of congestion control in TCP/IP Network.

15CSE387 OPEN LAB. 0 1 2 2

Open Labs are introduced to help with more programming. In addition students can learn specific state of art technologies that can help them prepare for the industry and higher studies. Tools like Open CV, Python, Open GL may be explored.

15CSE390 / 15CSE490 LIVE-IN-LAB. 3 cr

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or rural sites during the vacations (after fourth semester or sixth semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab

project, in the fifth or seventh semester. The objectives and projected outcome of the project should be reviewed and approved by the Dept. chairperson and a faculty assigned as the project guide. On completion of the project, the student shall submit a detailed project report. The report shall be evaluated and the students shall appear for a viva-voce test on the project.

15CSE401 MACHINE LEARNING AND DATA MINING 3 0 0 3

Unit 1

Introduction to Machine learning: Supervised learning, Unsupervised learning, some basic concepts in machine learning, Review of probability, Computational Learning theory. Bayesian concept learning, Likelihood, Posterior predictive distribution, Naive Bayes classi?ers, The log-sum-exp trick, Feature selection using mutual information, Linear Regression, Logistic regression.

Unit 2

Introduction to data mining - challenges and tasks, measures of similarity and dissimilarity, Classification - Rule based classifier, Nearest - neighbour classifiers -Bayesian classifiers - decision trees; support vector machines, Class imbalance problem performance evaluation of the classifier, comparison of different classifiers.

Unit 3

Association analysis – frequent item generation rule generation, evaluation of association patterns. Cluster analysis, K means algorithm, cluster evaluation, application of data mining to web mining and Bioinformatics. Classifying documents using bag of words advertising on the Web, Recommendation Systems, and Mining Social network graphs.

TEXTBOOKS:

1. *Kevin P. Murphey, "Machine Learning, a probabilistic perspective", The MIT Press, 2012.*
2. *Jiawei Han and MichelineKamber, Jian Pei, "Data Mining: Concepts and Techniques", Third Edition, Elsevier, 2012.*

REFERENCES:

1. *Pang-Ning Tan, Michael Steinbach and Vipin Kumar, "Introduction to Data Mining", First Edition, Pearson Education, 2006.*
2. *Tom Mitchael, "Machine Learning", McGraw Hill, 1997.*

15CSE402 STRUCTURE AND INTERPRETATION OF COMPUTER PROGRAMS 3 1 0 4

Unit 1

Introduction to LISP and Scheme – Building abstractions with procedures: Elements of programming procedures and processes they generate – Formulating abstracts with higher-order procedures.

Unit 2

Building abstractions with data: Introduction to data abstraction – Hierarchical data and the closure property – Symbolic data – Multiple representations for abstract data – Systems with genertic operations.

Unit 3

Modularity, object and state: Assignment and local state – Environment model of evaluation – Modeling with mutable data – Concurrency – Streams

TEXTBOOK:

Abelson H and Sussman G. J., "Structure and Interpretation of Computer Programs", Second Edition, MITPress, 2005.

REFERENCES:

1. *Brian Harvey and Matthew Wright, "Simple Scheme: Introducing Computer Science", Second Edition, MIT Press, 1999.*
2. *M. Felleisen, R. B. Findler. M. Flatt and S. Krishnamurthy, "How to Design Programs: An Introduction to Programming and Computing", MIT Press, 2001.*
3. *Daniel P. Friedman and M. Felleisen, "The Little Schemer", Fourth Edition, MIT Press, 1995.*
4. *Daniel P. Friedman and M. Felleisen, "The Seasoned Schemer", MIT Press, 1995.*

15CSE411 SOFTWARE PROJECT MANAGEMENT 3 0 0 3

Unit 1

Introduction to Software Project Management - Software Projects - ways of categorizing software projects – problems with software projects - Project Life Cycle – Management - Setting objectives – Stakeholders - Project Team – Step Wise: An overview of project planning - Project evaluation - Selection of appropriate project approach. Software effort estimation – function point analysis - objects point – COCOMO.

Unit 2

Activity planning - project schedules - sequencing and scheduling projects - Network planning models - AON and AOA - identifying critical activities - crashing and fast tracking, Risk management: Categories, Risk planning, management and control - Evaluating risks to the schedule, PERT. Resource allocation - identifying resource requirements - scheduling resources - creating critical paths - publishing schedule - cost schedules - sequence schedule.

Unit 3

Monitoring and control – Visualizing progress, Earned value analysis – Managing people and organizing teams – organizational structures - Planning for small projects. Case Study: PMBOK. Agile Development.

TEXTBOOK:

Hughes B, Cotterell M and Rajib M, "Software Project Management", Fifth Edition, Tata McGraw-Hill, 2012.

REFERENCES:

1. *Pressman R S, "Software Engineering – A Practitioner's Approach", Eighth Edition, McGraw-Hill Publishers, 2014.*
2. *Jalote P, "Software Project Management in Practice", Second Edition, Pearson Education, 2003.*

15CSE481 MACHINE LEARNING AND DATA MINING LAB. 0 0 2 1

This should be a Case Study involving classification including document classification or clustering including graph clustering with applications like recommendation systems, advertising on the web, using ML tools.

15CSE495 PROJECT PHASE I 2 cr

More credits for practical application of Computer Science and help students innovate. Support for publications, patenting and entrepreneurship through such efforts.

Identifying the domain, literature survey, problem definition, design, and partial implementation.

15CSE499 PROJECT PHASE II 10 cr

More credits for practical application of Computer Science and help students innovate. Support for publications, patenting and entrepreneurship through such efforts.
Implementation of the project, testing, paper preparation, and documentation.

15CUL101 CULTURAL EDUCATION I 2 0 0 2

Unit 1

Introduction to Indian Culture; Introduction to Amma's Life and Teachings; Symbols of Indian Culture.

Unit 2

Science and Technology in ancient India; Education in Ancient India; Goals of Life - Purusharthas; Introduction to Vendanta and Bhagavat Gita.

Unit 3

Introduction to Yoga; Nature and Indian Culture; Values from Indian History; Life and work of Great Seers of India.

TEXTBOOKS:

1. *The Glory of India (in–house publication)*
2. *The Mother of Sweet Bliss (Amma's Life & Teachings)*

15CUL111 CULTURAL EDUCATION II 2 0 0 2

Unit 1

1. Relevance of Sri Rama and Sri Krishna in this Scientific Age
2. Lessons from the Epics of India
3. Ramayana & Mahabharata

Unit 2

4. Who is a Wise Man?
5. A Ruler's Dharma
6. The Story of King Shibi

Unit 3

7. Introduction to the Bhagavad Gita
8. Bhagavad Gita – Action without Desire

Unit 4

9. Role and Position of Women in India
10. The Awakening of Universal Motherhood

Unit 5

11. Patanjali'sAstanga-Yoga System for Personality Refinement
12. Examples of Heroism and Patriotism in Modern India

TEXTBOOKS:

Common Resource Material II (in-house publication)

Sanatana Dharma- The Eternal Truth (A compilation of Amma's teachings on Indian Culture)

15CUL230 ACHIEVING EXCELLENCE IN LIFE - AN INDIAN PERSPECTIVE 2 0 0 2

OBJECTIVES: *The course offers to explore the seminal thoughts that influenced the Indian Mind on the study of human possibilities for manifesting excellence in life. This course presents to the students, an opportunity to study the Indian perspective of Personality Enrichment through pragmatic approach of self analysis and application.*

Unit 1

Goals of Life – Purusharthas

What are Purusharthas (Dharma, Artha, Kama, Moksha); Their relevance to Personal life; Family life; Social life & Professional life; Followed by a Goal setting workshop;

Yogic way of Achieving Life Goals – (Stress Free & Focused Life)
Introduction to Yoga and main schools of Yoga; Yogic style of Life & Time Management (Work Shop);

Experiencing life through its Various Stages
Ashrama Dharma; Attitude towards life through its various stages (Teachings of Amma);

Unit 2

Personality Development
What is Personality – Five Dimensions – Pancha Kosas (Physical / Energy / Mental / Intellectual / Bliss); Stress Management & Personality; Self Control & personality; Fundamental Indian Values & Personality;

Learning Skills (Teachings of Amma)
Art of Relaxed Learning; Art of Listening; Developing 'Shraddha' – a basic qualification for obtaining Knowledge;

Communication Skills - An Indian Perspective;

Unit 3

Developing Positive Attitude & Friendliness - (Vedic Perspective);

Achieving Work Excellence (Karma Yoga by Swami Vivekananda & teachings based on Amma);
Leadership Qualities – (A few Indian Role models & Indian Philosophy of Leadership);

REFERENCE BOOKS:

1. *Awaken Children (Dialogues with Sri Mata Amritanandamayi) Volumes 1 to 9*
2. *Complete works of Swami Vivekananda (Volumes 1 to 9)*
3. *Mahabharata by M. N Dutt published by Parimal publications – New Delhi (Volumes 1 to 9)*
4. *Universal message of Bhagavad-Gita (An exposition of Gita in the light of modern thought and Modern needs) by Swami Ranganathananda. (Vols.1 to 3)*
5. *Message of Upanishads, by Swami Ranaganathananda published by Bharatiya Vidya Bhavan, Bombay.*
6. *Personality Development – Swami Vivekananda published by Advaitha Ashram, Kolkatta.*
7. *Art of Man Making - Swami Chinmayananda published by Chinmaya Mission, Bombay*
8. *Will Power and its Development- Swami Budhananda published by Advaitha Ashram, Kolkatta*
9. *Ultimate Success - Swami Ramakrishnananada Puri published by Mata Amritanandamayi Math, Kollam*

10. *Yoga In Daily Life - Swami Sivananda – published by Divine Life Society*
11. *Hindu Dharma - H. H. Sri Chandrasekharandra Saraswati published by Bharatiya Vidya Bhavan, Bombay*
12. *All about Hinduism – Swami Sivananda - Published by Divine Life Society*
13. *The Mind and its Control by Swami Budhananda published by Advaitha Ashram, Kolkatta*
14. *Krida Yoga - Vivekananda Kendra, Publication.*
15. *Valmiki Ramayana – Four volumes- published by Parimal Publications, Delhi*
16. *New perspectives in Stress Management - Dr H R Nagendra & Dr R Nagaratna published by Swami Vivekananda Yoga Prakashana, Bangalore.*
17. *Mind Sound Resonance Technique (MSRT) Published by Swami Vivekananda Yoga Prakashana, Bangalore.*
18. *Yoga & Memory - Dr H R Nagendra & Dr. Shirley Telles, published by Swami Vivekananda Yoga Prakashana, Bangalore.*

15CUL231 EXCELLENCE IN DAILY LIFE 2 0 0 2

Unit 1

1 The anatomy of 'Excellence'. What is 'excellence'? Is it judged by external factors like wealth?
2 The Great Flaw. The subject-object relationship between individual and world. Promote subject enhance excellence.
3 To work towards excellence, one must know where he is. Our present state... An introspective analysis. Our faculties within.

Unit 2

4 The play of the mind. Emotions – convert weakness into strength.
5 The indispensible role of the intellect. How to achieve and apply clear thinking?
6 The quagmire of thought.The doctrine of Karma – Law of Deservance.
7 Increase Productivity, reduce stress.. work patterning.

Unit 3

8 The art of right contact with the world. assessment, expectations.
9 Myths and Realities on key issues like richness, wisdom, spirituality.
10 Collect yourself, there is no time to waste. The blue-print of perfect action.

REFERENCES:

The Bhaja Govindam and the Bhagavad Gita.

15CUL232 EXPLORING SCIENCE AND TECHNOLOGY IN ANCIENT INDIA 2 0 0 2

OBJECTIVES: *This course offers a journey of exploration through the early developments in India of astronomy, mathematics, technologies and perspectives of the physical world. With the*

help of many case studies, the students will be equipped to understand concepts as well as well as actual techniques.

Unit 1

1. General introduction: principles followed and sources;
2. Astronomy & mathematics from the Neolithic to the Indus civilization;
3. Astronomy & mathematics in Vedic literature;
4. Vedanga Jyotisha and the first Indian calendars;
5. Shulba Sutras and the foundations of Indian geometry;

Unit 2

6. Astronomy & mathematics in Jain and Buddhist literature;
7. The transition to the Siddhantic period; Aryabhata and his time;
8. The Aryabhatiya: concepts, content, commentaries;
9. Brahmagupta and his advances;
10. Other great Siddhantic savants;
11. Bhaskara II and his advances;

Unit 3

12. The Kerala school of mathematics;
13. The Kerala school of astronomy;
14. Did Indian science die out?;
15. Overview of recent Indian scientists, from S. Ramanujan onward;
16. Conclusion: assessment and discussion;

TEXTBOOK:

Indian Mathematics and Astronomy: Some Landmarks, by S. Balachandra Rao

REFERENCE:

IFIH's interactive multimedia DVD on Science & Technology in Ancient India.

15CUL233 YOGA PSYCHOLOGY 2 0 0 2

OBJECTIVES: *This course offers the foundation necessary to understand Eastern approaches to psychology and spirituality. The course includes experiential components centering on meditation and spiritual practice.*

Unit 1

Introduction

Introduction to Modern Psychology

A short history of Modern Psychology - Major Schools of Modern Psychology - The three major forces in Western Psychology - Freudian Psychoanalysis; Behaviourism; Humanistic Psychology.

Introduction to Indian Psychology

What is Yoga? - Rise of Yoga Psychology tradition - Various schools of Yoga Psychology - Universal Goal of all Yoga-schools.

Patanjali Yoga Sutra – 1

Introduction to Rishi Patanjali - Bird view of Yoga-Sutra - Definition of Yoga – Vrittis.

Patanjali Yoga Sutra – 2

Five Kinds of Vrittis - Pramanam - sources of right knowledge - Viparyayah – unfolded belief - Vikalpah – Unfolded belief - Smriti – Memory.

Unit 2

Patanjali Yoga Sutra – 3

Two formulae - Necessity of Abhyasah and Vairagyah - Foundation of Abhyasah - Foundation of Vairagyah.

Patanjali Yoga Sutra – 4

Introduction to Samadhi - Samprajnata-Samadhi - Reasoning in Samprajnata-Samadhi - Reflection in Samprajnata-Samadhi - Bliss in Samprajnata-Samadhi - Sense of Individuality in Samprajnata-Samadhi.

Patanjali Yoga Sutra – 5

Main obstacles in the path of Yoga - other obstructions - removal of obstacles by one – pointedness; by controlling Prana - by observing sense experience - by inner illumination - by detachment from matter - by knowledge of dream and sleep - by meditation as desired.

Patanjali Yoga Sutra – 6

How to make mind peaceful? - Cultivating opposite virtues: happiness – friendliness - misery – compassion - virtue – gladness - vice – indifference.

Patanjali Yoga Sutra – 7

Five causes of Pain - avidya – ignorance (Root Cause) - asmita – 'I-Feeling' - raga – attraction - dwesha – repulsion - abhinivesha – clinging to life.

Unit 3

Patanjali Yoga Sutra – 8

Necessity of Yoga practice - eight parts of Yoga practice - five Yamas: ahimsa – satya – asteya – brahmacharyam – aparigraha.

Patanjali Yoga Sutra – 9

Five Niyamas: Soucha – Santhosha – Tapas – Swadyah – Ishwara - Pranidhanam.

Patanjali Yoga Sutra – 10
Asanam – Pranayamah - various kinds of Pranayamah - Pratyaharah - Mastery over the senses.

Report review

Conclusion

REFERENCES:

- *The course book will be "The four chapters of Freedom" written by Swami Satyananda Saraswati of Bihar School of Yoga, Munger, India.*
- *"The message of Upanishads" written by Swami Ranganathananda. Published by Bharathiya Vidya Bhavan.*
- *Eight Upanishads with the commentary of Sankaracharya, Translated by Swami Gambhirananda, Published by Advaita Ashram, Uttaranjal.*
- *'Hatha Yoga Pradipika' Swami Muktibodhananda, Yoga Publications Trust, Munger, Bihar, India*

15CVL102 MECHANICS: STATICS AND DYNAMICS 2 1 0 3

Unit 1

Principles of statics: Introduction to vector approach – free body diagrams – forces in plane – forces in space – concurrent forces - resolution of forces – equilibrium of particle.

Statics of rigid bodies in two dimensions and three dimensions: Moment of a force about a point – moment of a force about an axis – moment of a couple – equivalent force couple system – rigid body equilibrium – support reactions.

Unit 2

Applications of statics: Friction – contact friction problems. Analysis of trusses – method of joints – method of sections.

Properties of surfaces and solids - Centroid, Moment of inertia, Polar moment of inertia, Mass moment of inertia, Product of inertia and Principal moment of inertia.

Unit 3

Dynamics: Rectangular and cylindrical coordinate system - Combined motion of rotation and translation - Newton's second law in rectilinear translation - D'Alembert's principle - Mechanical vibration - Simple harmonic motion - Spring-mass model.

TEXTBOOKS:

1. *Beer, F. P. and Johnston, E. R., "Vector Mechanics for Engineers- Statics and Dynamics", 8/e, McGraw Hill International Book Co., 2008.*

2. *Shames, I. H, "Engineering Mechanics – Statics and Dynamics", 4/e, Prentice–Hall of India Pvt. Ltd., 2003.*

REFERENCES:

Hibbeler, R. C., "Engineering Mechanics', 12/e, Pearson Education Pvt. Ltd., 2007.
Meriam, J. L., "Dynamics", 5/e, John Wiley & sons, 2003.
K. L. Kumar, "Engineering Mechanics", 3/e, Tata McGraw Hill, 2003.

15CVL111 INTRODUCTION TO CIVIL ENGINEERING 1 0 0 1

Introduction to the various areas of Civil engineering - Simple concepts in each of the areas - Respective tasks performed by each specialty which contributes to a constructed facility.

Introduction to the Civil engineering undergraduate curriculum map - the relationship between the courses in the curriculum.

15CVL112 ENGINEERING GRAPHICS – CAD 1 0 2 2

Section of Solids: Introduction, Section planes, Sectional views, apparent shapes and true shapes of sections of right regular prisms, cylinders, pyramids and cones.

Development of lateral surfaces: Introduction, Development of lateral surfaces of prisms, cylinders, pyramids and cones.

Isometric Projection: Introduction, Isometric scale, Isometric projection of prisms, pyramids, cylinders, cones

Orthographic Views of 3 dimensional solids.

Building Drawing: Construction details – Masonry, Footings.

Development of Plan, Section and Elevation of Simple Residential building.

TEXTBOOKS:

1. *Bhat N. D. and Panchal V. M., "Engineering Drawing Plane and Solid Geometry, 42e, Charoatar Publishing House, 2010*
2. *Dr. Balagopal T S Prabhu, Dr. K. Vinent Paul and Dr. C. Vijayan., "Building Design and Civil Engineering Drawing", Spades Publishers & Distributors, Calicut, 2012.*

REFERENCE BOOKS:

1. *James D. Bethune, "Engineering Graphics with AutoCAD", Pearson Education, 2014*
2. *K. R. Gopalakrishna, "Engineering Drawing", 2014, Subhas Publications*
3. *Narayan K. L. and Kannaiah P, Engineering Drawing, SciTech Publications, 2003*

15CVL201 CONSTRUCTION MATERIALS 3 0 0 3

Unit 1

Commonly used building materials - relationship between material structure and properties.

Masonry materials - stones, bricks, blocks; Refractory products; Timber and wood based products - Classification, properties, testing and selection criteria.

Unit 2

Binding materials (Lime, gypsum, cement) and Mortars - types, properties, tests.

Concrete – Aggregates – Mechanical and Physical properties and tests – Grading requirements – Water quality – Admixtures. Properties of concrete in fresh and hardened state – workability – segregation and bleeding – tests on workability and strength. Stress – strain characteristics and elastic properties – shrinkage and creep. Mix proportioning (B.I.S method) – nominal mixes.

Unit 3

Metals – Structural steel - properties and uses - sections – Reinforcing steel – use of Aluminium. Bituminous materials – types and properties of asphalt, bituminous concrete.

Modern construction materials – Paints, Glass, Ceramics, Polymers and plastics, Adhesives, Composites and smart materials. Recycling of industrial waste as building materials.

TEXTBOOKS:

1. *Duggal, S. K., "Building Materials", New Age International Publishers, 2012.*
2. *Santhakumar. A. R., "Concrete Technology", Oxford University press, 2006.*

REFERENCE BOOKS:

1. *Young. J. F. and Mindess, S., "The Science and Technology of Civil Engineering Materials", Prentice Hall, 1997.*
2. *Mehta, P. K. and Monteiro, P. J. M., "Concrete-Microstructure, Properties and Materials", Tata McGraw Hill, 2006.*
3. *Rangwala S. C, "Engineering Materials", Charotar Publishing House, 2011.*
4. *Shetty, M. S, "Concrete Technology-Theory and Practice", S. Chand & Co., New Delhi, 2009.*
5. *Gambhir, M. L. and Neha Jamwal, "Building Materials", Tata McGraw Hill, 2011.*

15CVL202 PINCIPLES OF FLUID MECHANICS 2 1 0 3

Unit 1

Elementary concepts – properties - concept of gauge and absolute pressure, measurement of pressure using manometers of different types.

Hydrostatic force on plane and curved surface – center of pressure – lock gates - buoyancy and stability of submerged and floating bodies - metacentric height - period of oscillation.

Types of flow, definitions and explanations of unsteady, steady, non-uniform, laminar and turbulent flows. Ideal flow - rotational and irrotational, stream function, potential function. Path line, streak line and stream line – continuity equation – derivation, application of one dimensional steady flow – circulation and vorticity - Basic flow fields such as uniform flow, source, sink, doublet, vortex flow, spiral flow – superposed flows.

Unit 2

Derivation of Bernoulli's energy equation and Euler's equation, examples illustrating the use of energy equation. Flow meters - venturimeter, Orifice meter, nozzle, derivation of equations of discharge, pitot tubes – applications to flow measurements - notches and weirs.

Laminar flow through circular pipe – shear stress, pressure gradient, velocity profile, Hagen-poiseuille's equation, power calculations, laminar flow between parallel plates - Couette flow and Poiseuille flow.

Flow in closed conduits – friction loss and flow calculations, turbulent flow, Reynolds number, Darcy-Weisbach equation. Use of Moody's diagram, minor losses – pipe networks – pipes in parallel and series - equivalent length.

Unit 3

Boundary layer theory, boundary layer equation – Prandtl equation, Blasius solution, drags on flat plate, boundary layer separation and its control.

Dimensional Analysis, Similitude and Model Analysis: Methods of Dimensional Analysis – Rayleigh's method – Buckingham Pi-theorem – Hydraulic Similitude – model analysis – dimensionless numbers – Model testing of partially submerged bodies – Distorted models and scale effects.

TEXTBOOKS:

1. *Streeter Victor L and E. Benjamin Wylie, "Fluid Mechanics", Tata McGraw Hill, 2010.*
2. *Modi P. N. and Seth S. M., "Hydraulics and Fluid Mechanics including Fluid Machines", Standard Publishers & Distributors, 2013.*

REFERENCE BOOKS:

1. *Cengel and Cimbala, "Fluid Mechanics", Tata McGraw Hill Publishers, 2010.*
2. *Som S K, Gautam Biswas and Suman Chakrabarty, "Introduction to Fluid Mechanics and Fluid machines", Tata McGraw Hill Education Pvt. Ltd, 2013*
3. *N. N. Pillai, "Fluid Mechanics and Fluid Machines", Universities Press, 2008.*

4. *Subramanya K., "Theory and Applications of Fluid Mechanics", Tata McGraw Hill Publishing Co, 1993.*
5. *J. F. Douglas, J. M. Gasiorek and J. A. Swaffield., "Fluid Mechanics", Pearson Education, 2008.*
6. *White, Frank. M, "Fluid Mechanics", Tata McGraw Hill, 2011.*

15CVL203 SOLID MECHANICS 3 1 0 4

Unit 1

Stress and strain at a point – tension, compression and shear stresses – Hooke's law - Poisson's ratio - relationship between elastic constants – compound bars - thermal stresses – strain energy in tension, compression and shear - resilience – stresses due to impact and suddenly applied load.

Different types of beam – statically determinate and indeterminate beams - shear force and bending moment diagrams - relationship between intensity of loading, shear force and bending moment.

Unit 2

Theory of simple bending - Stress distribution at a cross-section due to bending moment forstatically determinate beams - flitched beams.

Shear stress distribution.

Unsymmetrical bending and Shear centre.

Torsion of circular solid and hollow shafts – combined bending moment and torsion on shafts – close coiled and open coiled helical springs

Complex stresses – principal stresses and principal planes - principal strains – graphical method.

Unit 3

Deflection of beams – double integration method – Macaulay's method – Area Moment method – Conjugate beam method – Strain energy approach.

Theory of columns – members subjected to axial load and bending moment – Euler's theory for long columns – assumptions and limitations – Rankine's formula. Thin and thick cylinders – Lame's equation - compound cylinders.

Theories of failure and applications in design.

TEXTBOOKS:

1. *Gere, J. M. and Goodno. B. J., "Mechanics of Materials", CL Engineering, 2012.*
2. *Beer, Johnston, DeWolf, Mazurek., "Mechanics of Materials", McGraw-Hill Education, 2013.*

REFERENCE BOOKS:

1. *Timoshenko, S. P., and Young, D. H., "Elements of Strength of Materials", East West Press, New Delhi, 2003.*
2. *Popov E. P., "Mechanics of Materials", Prentice Hall India, New Delhi, 2002*
3. *Crandall, S. H., Dahal, N. C., and Lardener, T. J., "An Introduction to Mechanics of Solids", McGraw Hill Books Co, 1985, 2nd Edition 2007*
4. *Nash W. A. "Strength of Materials", McGraw Hill Book Company, 2006*

15CVL204 SURVEYING 3 1 0 4

Unit 1

Introduction - classification of surveys – reconnaissance - principle of working from whole to part – provision of control – conventional signs

Chain survey – instruments – principles of chain survey – field book – plotting – tie line and check line.

Compass survey – types of compass – types of bearings – dip and declination – local attraction – traversing – plotting - error of closure.

Plane table survey - two point problem – three point problem – errors in plane tabling.

Unit 2

Levelling – leveling instruments and its adjustments – fly leveling – booking - corrections for refraction and curvature – reciprocal leveling – longitudinal leveling and cross sectioning – contour surveying – definition – characteristics, methods and uses of contouring – plotting – areas and volumes – planimeter - Earthwork volume calculation. Theodolite surveying – study of theodolite and its adjustments - measurement of horizontal angles - vertical angles – heights and distances – theodolite traverse – calculation of co-ordinates – corrections – traversing conditions for closure.

Unit 3

Minor instruments – hand levels – clinometer – Ceylon ghat tracer – hypsometer – pantagraph – ediograph – box sextant - telescopic alidade.
Curves – simple, transition and vertical curves - curve setting by various methods.

Tacheometric surveying – various methods – instrument constants – analytic lens – tangential system – direct reading tacheometer - subtense bar – trigonometric

leveling. Total station - introduction to photogrammetry, remote sensing, global positioning systems, and Geographic information systems. EDM.

Introduction to Hydrographic surveying.

TEXTBOOKS:

1. *Kanetkar T. P. and Kulkarni S. V., "Surveying and Levelling", Vol. I & II, Vidyarthi Griha Prakashan, 2006.*
2. *Arora K. R., "Surveying", Vol. I & II, Standard Publishers, 2010.*

REFERENCE BOOKS:

1. *Bannister, A. and Baker, R., "Solving Problems in Surveying", Addison Wesley Longman, 1996.*
2. *R. Agor, "Textbook of Surveying and Levelling", Khanna Publishers, 2012.*
3. *S. K Duggal, "Surveying", Vol. 1 & 2, McGraw Hill Education, 2013.*
4. *R. Subramanian, "Surveying and Leveling", Oxford University Press, 2012.*
5. *Pradip Kumar Guha, "Remote Sensing for the Beginner", Affiliated East West Press, 2003.*

15CVL211 BUILDING TECHNOLOGY 3 0 0 3

Unit 1

Occupancy classification of buildings - Essentials of National Building Code.

Loads on buildings; Foundations - deep and shallow foundations – introduction to mat and grillage foundations – caissons.

Super structure - load bearing masonry - brick and stone masonry, arches, lintels, scaffolding, shoring; plastering and pointing.

Unit 2

Concrete construction – batching, mixing, conveying, placing, compacting, curing. Durability of concrete. Special concretes.

Reinforced concrete - Form work - Prestressed concrete. Principles of prefabricated construction.

Roofs and Floors - flat and pitched roofs, floor types and finishes; Doors and windows.

Damp and water proofing techniques.

White washing, colour washing, painting and distempering;

Unit 3

Tall buildings – structural systems – Steel and concrete framed construction - Vertical transportation, plumbing systems, electrical services

Thermal insulation of buildings - Natural and mechanical ventilation - Air conditioning. Principles of fire resistant construction. Acoustics - requirements for good acoustics - sound insulation.

Functional planning – Building development rules - Space planning of buildings – Design process – planning principles.

TEXTBOOKS:

1. *Arora.S. P. and Bindra.S. P.,"Building Construction", Dhanpat Rai Publications, New Delhi, 2005.*
2. *Santha Kumar, A. R., "Concrete Technology", Oxford University Press, 2006.*

REFERENCE BOOKS:

1. *Rangwala S. C, "Building Construction", Charotar Publishing House, 2007.*
2. *National Building Code, Bureau of Indian Standards, 2005.*
3. *Neville.A. M. And Brooks.J. J., "Concrete Technology", Pearson Education, 2004.*
4. *Punmia, "Building Construction", Laxmi Publications, 2009.*
5. *Subir K Sarkar and Subhajit Saraswati, "Construction technology", Oxford University Press, 2008.*

15CVL212 GEOLOGY AND SOIL MECHANICS 2 1 0 3

Unit 1

General geology – Weathering - Geological work of wind, rivers and oceans.Mineralogy.

Petrology – Three-fold classification of rocks and their characteristic features.

Structural geology - Types and classification of structures (Joints, Unconformities, Folds and faults) and their effect on civil engineering projects.

Geology in Civil Engineering - Tunnels, dams, reservoirs, bridges, runways, roads and buildings. Physico-Mechanical properties of rock. Origin and formation of soils.

Unit 2

Soil structure and clay mineralogy – Adsorbed water – Mass-volume relationship – Relative density. Index Properties of Soils: Grain size analysis – Sieve and hydrometer methods – consistency limits and indices – I.S. Classification of soils.

Permeability: Soil water – capillary rise – flow of water through soils – Darcy's law- permeability – Factors affecting permeability – laboratory determination of coefficient of permeability – Permeability of layered systems.

Seepage through soils: Total, neutral and effective stresses – quick sand condition – Seepage through soils – Flownets: characteristics and uses.

Unit 3

Stress distribution in soils: Boussinesq's and Westergaard's theories for point loads and areas of different shapes – Newmark's influence chart.

Compaction: Mechanism of compaction – factors affecting – effects of compaction on soil properties – Field compaction equipment - compaction control.

Consolidation: stress history of clay; e-p and e-log p curves – magnitude and rate of 1-D consolidation – Terzaghi's Theory.

TEXTBOOKS:

1. *Venkat Reddy, D., "Engineering Geology", Vikas Publishing House, 2010.*
2. *Gopal Ranjan and A. S. R. Rao, "Basic and Applied Soil Mechanics", New Age International Publishers, 2005.*

REFERENCE BOOKS:

1. *Blyth. F. G. H. and M. H. De Freitas, "Geology for Engineers", 7th Edition, Elsevier Science, 2006.*
2. *Parbin Singh., "Engineering and General Geology", S. K. Kataria and Sons, 2009.*
3. *Das, B. M., "Principles of Geotechnical Engineering", CL Engineering, 2013.*
4. *C. Venkataramiah, "Geotechnical Engineering", New Age International Publishers, 2006.*
5. *T. W. Lambe and Whitman, "Soil Mechanics", Wiley, 2008.*
6. *Manoj Dutta and Gulhati S. K, "Geotechnical Engineering", Tata McGraw Hill Publishers,2005.*

15CVL213 HYDRAULIC ENGINEERING 2 1 0 3

Unit 1

Impulse momentum principle – application – impact of jet-force exerted by a jet on normal, inclined and curved surfaces for stationary and moving cases – torque in rotating machines – jet propulsion.

Hydroelectric power: low, medium and high head plants - Power house components – Micro-hydel schemes. Turbines - classifications – construction and working of Pelton Wheel, Francis and axial flow reaction turbines - selection of turbines – draft tube.

Classification of pumps – Centrifugal pumps – types and working – characteristics. Reciprocating pumps - types and working – selection of pumps.

Unit 2

Open channel flow - Comparison with pipe flow, Types of channels - Classification of flow, uniform flow – Uniform flow using chezy's and Manning's formulae - Most efficient channel section – Circular, Rectangular and Trapezoidal channel sections, open channel section for constant velocity at all depths of flow. Specific energy and critical depth, Specific force curve, critical flow computation.

Non-uniform flow, Gradually Varied Flow, Dynamic equation for gradually varied flow, Different forms of the dynamic equation, Flow profiles in prismatic channels, integration of the varied flow equation - Computation of the length of the backwater curve and afflux. Rapidly Varied Flow - Hydraulic Jump, Hydraulic jump equations for a rectangular channel, Practical applications.

Unit 3

Rivers - their behaviour - Control and training. Design of stable channels in India - problem in India - Classification of irrigation canals, Canal alignment, Design procedure for an irrigation channel - Considerations for fixing longitudinal section of a channel - Cross sections of an irrigation channel, Maintenance of canals, Canals in alluvial soils – Regime Theory - Kennedy's and Lacey's Theories, Silting in canals, Scour and protection against scour. Canal lining - losses in irrigation canals, Advantages and disadvantages of lining, Types of lining. Water logging - Causes and preventive measures. Design of lined canals - irrigation canals - Kennedy's Theory - Lacey's Theory.

TEXTBOOKS:

1. *Modi P. N. and Seth S. M., "Hydraulics and Fluid Mechanics including Fluid Machines", Standard Book House, 2002.*
2. *Garg, S. K., "Irrigation Engineering and Hydraulic Structures", Khanna Publishers, 2006.*

REFERENCE BOOKS:

1. *Chow V. T., "Open Channel Hydraulics", McGraw Hill, Inc. 1959.*
2. *Rajput R K, "Fluid mechanics and Hydraulic Machines", S Chand Publishers, 2008.*
3. *N. N. Pillai, "Fluid Mechanics & Fluid Machines", Universities Press, Third Edition, 2009.*
4. *K. Subramanya, "Flow in Open Channels", Tata McGraw Hill, 1997.*
5. *M. Hanif Chaudhry, "Open Channel Flow", Prentice Hall of India, 1994.*
6. *K. G. Rangaraju, "Flow Through Open Channels", Tata McGraw Hill, 1984.*
7. *Jagdish Lal, "Hydraulic Machines including Fluidics", Metropolitan Book Co, 2003.*
8. *P. N. Modi, "Irrigation, Water Resources, and Water Power Engineering", Standard Publishers Distributors, 2008.*

15CVL214 STRUCTURAL ANALYSIS 2 1 0 3

Unit 1

Statically indeterminate structures - degree of static and kinematic indeterminacies. Introduction to force and displacement methods of analysis.

Energy principles – Castigliano's theorems - Engessor's theorem - Maxwell Betti's theorem - Principle of least work – Method of virtual work (unit load method) - applications in statically determinate and indeterminate structures.

Analysis of Propped cantilever and fixed beams.

Unit 2

Cables – maximum tension – types of supports – forces in towers – suspension bridges with three and two hinged stiffening girders.

Theory of arches – Eddy's theorem – analysis of three hinged and two hinged arches – settlement and temperature effects.

Beams curved in plan – analysis of cantilever beam curved in plan – analysis of circular beams over simple supports.

Unit 3

Moving loads and influence lines – influence lines (IL) for statically determinate beams for reaction, SF and BM – effect of moving loads – concentrated and uniformly distributed loads – load position for maximum BM and SF - equivalent UDL.

IL for determinate structures – truss, arch and suspension bridge.

TEXTBOOKS:

1. *Devdas Menon, "Structural Analysis", Narosa Book Distributors Pvt Ltd, 2013.*
2. *S P Gupta and G S Pundit, "Theory of Structures", Vol. I & II, Tata McGraw Hill, 1999*

REFERENCEBOOKS:

1. *Wang C. K., "Intermediate Structural Analysis" Tata McGraw - Hill Education 2010.*
2. *Norris C. H, Wilbur J. B. and Utku. S., "Elementary Structural Analysis", Tata McGraw Hill, 1991.*
3. *Sujit Kumar Royand Subrata Chakrabarty, "Fundamentals of Structural Analysis", S. Chand & Co., 2010.*
4. *S. B. Junnarkar and H. J. Shah, "Mechanics of Structures Vol. II", 20th Edition, Charotar Publishing House, 2008.*
5. *Reddy C. S., Basic Structural Analysis, Tata McGraw Hill, New Delhi, 2015.*

6. *L. S. Negi and R. S. angid, Structural Analysis, Tata McGraw Hill, 2003.*
7. *D S Prakash Rao, "Structural Analysis A Unified Approach", Universities Press (India) Ltd., 1996.*

15CVL281 MATERIALS TESTING LAB. 0 0 2 1

1. Tension test on metals
2. Tensile test on thin wires – Mild steel and Copper
3. Compression test – Wood specimen and brick
4. Hardness test on Ferrous and non-ferrous material - Rockwell Hardness test - Brinell Hardness test
5. Double shear test on mild steel rods
6. Deflection test on beams
7. Impact test on metal specimens – Izod and Charpy
8. Flexural test on timber beams
9. Test on helical Spring - Open coiled and close coiled
10. Fatigue test on metals

15CVL282 SURVEY PRACTICE 1 0 2 2

1. Chain & Compass survey- Traversing and plotting of details
2. Plane table survey - two point & three point problems – traversing
3. Levelling - Plane of collimation & Rise and fall method
4. Levelling - Longitudinal & cross sectioning
5. Contour surveying
6. Theodolite surveying - Measurement of angles and traversing
7. Heights and distances by tacheometry and solution of triangles
8. (a) Total Station – Traversing and Area Calculation
   (b) Area calculation using Planimeter.
9. Mapping using GPS
10. Study of Minor instruments
11. Study of modern survey instruments - Automatic levels, Electronic theodolite.

15CVL285 CONSTRUCTION MATERIALS LAB. 0 0 2 1

1. Tests on cement - Fineness, Normal consistency, Initial and Final Setting times, Specific gravity, Compressive strength, Soundness
2. Tests on fine aggregate - Grain size distribution – Uniformity coefficient and fineness modulus, Specific gravity, Density, Void ratio, Bulking &Absorption
3. Tests on coarse aggregate - Grain size distribution – Uniformity coefficient and fineness modulus, Specific gravity, Density, Void ratio, Absorption, Crushing & Impact values, Flakiness & Elongation, Los Angel's Abrasion test

4. Test on fresh and hardened concrete
   (a) Workability test - Slump test, Compaction factor test, Flow table test, Vee-Bee Consistometer,
   (b) Use of water reducing admixtures
   (c) Compressive strength, Split tensile strength, Flexure test on beams, Modulus of elasticity
5. Tests on bricks – Crushing strength, water absorption and efflorescence
6. Basic tests on Bitumen.

15CVL286 HYDRAULIC ENGINEERING LAB. 0 0 2 1

1. Study of instruments: pressure gauge - piezometer – manometer-pressure transducers - pitot tubes - current meter.
2. Verification of Bernoulli's equation.
3. Determination of Coefficient of discharge for a small orifice by a constant head method.
4. Determination of Coefficient of discharge for an external mouth piece by variable head method.
5. Calibration of Triangular Notch
6. Determination of friction factor of pipes
7. Impact of jet on vanes
8. Calibration of Venturimeter, Orificemeter, rotameter and watermeter
9. Determination of metacentric height
10. Performance test on Pelton wheel turbine and Francis turbine.
11. Efficiency test on centrifugal pump and reciprocating pump.
12. Open channel flow: Manning's coefficient, specific energy curve, Tracing back water profiles/draw down profiles, Hydraulic jump parameters

15CVL301 ADVANCED STRUCTURAL ANALYSIS 2 1 0 3

Unit 1

Slope deflection method – application to the analysis of statically indeterminate beams with and without settlement of supports - rigid jointed plane frames with and without side sway - gable frames.

Analysis of continuous beams - theorem of three moments.

Sway and non-sway analysis by Moment distribution method and Kani's method.

Unit 2

Approximate Methods of Analysis of Multistoried Frames: Analysis for vertical loads – substitute frames - loading conditions for maximum moments in beams and columns – portal method and cantilever method for lateral load analysis.

Unit 3

Matrix methods of structural analysis - stiffness and flexibility matrices for elements and structure - analysis of continuous beams, simple rigid jointed frames and plane trusses by stiffness and flexibility method.

Introduction to FEM.

TEXTBOOKS:

1. *Devdas Menon, "Structural Analysis", Narosa Book Distributors Pvt. Ltd, 2013.*
2. *Gupta S. P and G .S Pundit, "Theory of Structures", Vol. I & II, Tata McGraw Hill, 1999.*

REFERENCE BOOKS:

1. *Hibbeler, R. C., "Structural Analysis", Pearson, 2008.*
2. *Wang C. K., "Intermediate Structural Analysis" Tata McGraw - Hill Education 2010.*
3. *Norris C. H, Wilbur J. B. and Utku. S., "Elementary Structural Analysis", Tata McGraw Hill, 1991.*
4. *Sujit Kumar Roy and Subrata Chakrabarty, "Fundamentals of Structural Analysis" S. Chand & Co., 2010.*
5. *Reddy C. S., "Basic Structural Analysis", Tata McGraw Hill, 2015.*

15CVL302 DESIGN OF CONCRETE STRUCTURES 3 1 0 4

Unit 1

Introduction to R. C structures – Review of basic material properties- Concrete and Reinforcing steel.

Design philosophies - Working stress method (WSM), Ultimate load method (ULM), Limit state method (LSM).

Design of Beams - singly and doubly reinforced rectangular and flanged sections. Serviceability requirements. Behaviour in Shear and Torsion; analysis and design with and without shear reinforcement.

Unit 2

Design for Bond: development length, splicing, curtailment.

Design of one-way slabs and two-way rectangular slabs (wall-supported) - as per IS 456: 2000.

Design of Compression Members: effective length, short columns subject to axial compression with and without uniaxial / biaxial eccentricities.

Unit 3

Introduction to slender columns. Design of isolated footing for axially loaded & eccentrically loaded columns, combined footing. Design of staircases.

Introduction to Prestessed concrete with simple examples.

TEXTBOOKS:

1. *Pillai S. U. and Menon D, "Reinforced Concrete Design", Tata McGraw Hill, 2009.*
2. *M. L. Gambhir, "Design of Reinforced Concrete Structures", PHI learning, 2009.*

REFERENCE BOOKS:

1. *Park and Paulay, "Reinforced Concrete Structures", Wiley India (P) Ltd, 2010*
2. *Varghese P. C., "Limit State Design of Reinforced Concrete", PHI Learning, 2009.*
3. *P. Dayaratnam, "Design of Reinforced Concrete Structures", Oxford University Press, 2011.*
4. *Jain A. K., "Reinforced Concrete - Limit State Design", Nem Chand & Bros., 2009.*
5. *Sinha S. N., "Reinforced Concrete Design", Tata McGraw Hill, 2005.*
6. *BIS Codes (SP 23, SP 24, IS 456, IS 875, IS 10262, IS 800, SP 16, IS 883, IS 2750)*
7. *Arthur H Nilson, "Design of Concrete Structures", Tata McGraw-Hill Publications, 2005.*

15CVL303 GEOTECHNICAL ENGINEERING 3 1 0 4

Unit 1

Shear strength of soils: Mohr – Coulomb Failure theories – Types of laboratory strengthtests – strength tests based on drainage conditions – Shear strength of sands – Critical Void Ratio – Liquefaction - shear strength of clays.

Soil Exploration: Need – Methods of soil exploration – Boring and Sampling methods – Field tests – Penetration Tests – Plate load test – Pressure meter – Planning of programme and preparation of soil investigation report.

Unit 2

Shallow Foundations: Types - choice of foundation – Location of depth – Safe Bearing Capacity – Terzaghi, Meyerhof, Skempton and IS Methods.

Safe bearing pressure based on N-value – allowable bearing pressure; safe bearing capacity and settlement from plate load test – allowable settlements of structures – Settlement Analysis.

Pile Foundation: Types of piles – Load carrying capacity of piles based on static pile formulae – Dynamic pile formulae – Pile load tests - Load carrying capacity of pile groups in sands and clays – Settlement of pile groups.
Well Foundations: Types – Components of well foundation – functions and design. Design Criteria – Sinking of wells – Tilts and shifts.

Unit 3

Earth Slope Stability: Infinite and finite earth slopes – types of failures – factor of safety of infinite slopes – stability analysis by Swedish arc method, standard method of slices, Bishop's Simplified method – Taylor's Stability Number.

Earth Pressure Theories: Rankine's theory of earth pressure – Earth pressure in layered soils – Coulomb's earth pressure theory – Culmann's graphical method.

Retaining Walls: Types of retaining walls – stability of retaining walls.

TEXTBOOKS:

1. *Gopal Ranjan and A. S. R. Rao, "Basic and Applied Soil Mechanics", New Age International Pvt. Ltd, 2004.*
2. *Venkataramaiah. C., "Geotechnical Engineering", New Age International Publishers, 2006.*

REFERENCE BOOKS:

1. *Varghese, P. C., "Foundation Engineering", PHI Learning, 2009.*
2. *Das, B. M., "Principles of Foundation Engineering", CL Engineering, 2013.*
3. *Bowles, J. E., "Foundation Analysis and Design", Tata McGraw Hill, 1996.*
4. *Swami Saran, "Analysis and Design of Substructures", Oxford and IBH Publishing Company Pvt Ltd, 2008 .*
5. *Teng, W. C, "Foundation Design", Prentice Hall, 1998.*

15CVL311 DESIGN OF STEEL STRUCTURES 3 1 0 4

Unit 1

Introduction to structural steel sections, material property, geometric properties, classes of sections, stresses, residual temperature stresses in rolled steel sections, loads. Types of design - rigid, semi rigid. Limit state design method – basic concepts, partial safety factors, load combinations, deflection limitations as per IS:800.

Analysis and design of bolted and welded connections to resist direct force and moment.

Design of tension members - single and double angle ties.

Unit 2

Plastic behaviour of structural steel – shape factor – plastic hinge concept – collapse load – methods of plastic analysis – plastic design of beams and portal frames. Local buckling of plates – stiffened edges.

Compression members: Axially and eccentrically loaded compression members - built up columns - lacings and battens - design of column bases.

Analysis and design of laterally restrained & unrestrained simple & compound beams - Design for flexure, shear, deflection, and bearing.

Unit 3

Industrial roofs: Introduction to steel roof systems - various elements - loads -

wind analysis – design of plane roof trusses – design of roofing elements and purlins – wind bracings - Gusset connections.

Introduction to cold-formed steel structures (Light gauge steel sections).

TEXTBOOKS:

1. *Subramanian N, "Design of Steel Structures", Oxford University Press, 2008.*
2. *Duggal, S. K., "Limit State Design of Steel Structures", Tata McGraw Hill, 2010.*

REFERENCE BOOKS:

1. *Ramchandra and Gehlot, "Limit State Design of Steel Structures", Scientific Publishers, 2010.*
2. *Dayaratnam P, "Design of Steel Structures", S. Chand & Co., 2003.*
3. *Arya and Ajmani, "Design of Steel Structures", Nem Chand Brothers, 2007.*
4. *BIS codes (IS 800-2007, IS 875-1987-Parts I, II, III, SP: 6 – Part 1 to 6).*
3. *Emil Smith and Robert Scanlan, "Wind Effects on Structures". Wiley-Interscience, 1986.*
4. *Edwin Gaylord, "Design of Steel Structure", Tata McGraw Hill Publishing Company Limited, 2010.*

15CVL312 ENVIRONMENTAL ENGINEERING I 2 1 0 3

Unit 1

Water Supply Systems: Need for protected water supply - objectives of water supply system. Factors affecting per capita consumption, fire demand, fluctuations in rate of consumption - population forecasting - Design periods for water supply components.

Intake Works and Transportation: Intakes - types, location, requirements and features. Transportation of water - Types of conduits - relative merits, selection, joints, hydraulic design, and cross-connected parallel pipe to increase capacity - pipe laying and testing.

Quality and Analysis of Water: Impurities in raw water - causes - effects / significance - analysis - tests - Bacteriology of water, bacteriological analysis - Water borne diseases - Standards of water quality.

Unit 2

Treatment of Water – Conventional Treatment flow charts - Principles of coagulation, flocculation and sedimentation - Design principles of - Flash mixer –Design and drawing (Detailed sketch) of Flocculator and Sedimentation tank.

Filtration - Principles of Filtration - Classification. Constructional and operational features of slow sand filters and rapid sand filters - Design criteria. Design and drawing (Detailed sketch) of slow sand filters and rapid sand filters.

Disinfection - methods and disinfectants - Disinfection devices – Chlorination, other methods. Miscellaneous treatment methods - aeration, taste and odour control, iron and manganese removal, water softening, fluoridation and defluoridation and demineralization - Residue Management.

Unit 3

Distribution of Water: Distribution network - Requirements of distribution system - Analysis by Hardy Cross method – Equivalent Pipe method – Computer application. Service reservoirs - functions, classification - Service reservoir design. Waste detection and prevention - Metered and unmetered water supplies. Necessity of pumping in water supply - classification and brief description of types of pumps - selection of pump - calculation of head, horsepower - economical diameter of pumping main.

Plumbing and Pumping: Drainage layout - plumbing components - traps and fittings - water seal - plumbing systems - choice - Principles governing drainage - plumbing design, IS Code provisions. Water supply of buildings - service connection to buildings.

TEXTBOOK:

Birdie G. S and Birdie J. S, "Water Supply and Sanitary Engineering", Dhanpat Rai & Sons, 2010.

REFERENCE BOOKS:

1. *Garg S. K, "Environmental Engineering", Vol. I, Khanna Publishers, 2004 .*
2 *Duggal, K. N., "Elements of Environmental Engineering", S Chand & Co. Ltd., 2007.*
2. *Mark J. Hammer and Mark J. Hammer Jr., "Water and Waste Water Technology", Prentice Hall of India Pvt. Ltd., 2008.*
3. *Sawyer and McCarty, "Chemistry for Environmental Engineering", Tata McGraw-Hill, 2003.*

15CVL313 TRANSPORTATION ENGINEERING I 2 1 0 3

Unit 1

Highway Engineering: Introduction to Transportation Systems and Study of System Characteristics; Salient features of first, second, third and fourth road development plans in India - planning surveys and master plan preparations.

Classification of Roads; Highway Planning; Geometrical Design – Road Cross Sections, Sight Distance and Applications, Super elevation, Horizontal and Vertical Alignment.

Unit 2

Pavement Materials, Design, Construction & Maintenance: Pavement Materials – Aggregate and Bitumen Characteristics and Testing, Bituminous Mix Design - Marshall Mix Design; Pavement Design – Design Elements and Loads. Design of flexible and rigid pavements – CBR method and guidelines of IRC method. Pavement Construction and maintenance– related equipment.

Unit 3

Traffic engineering and control: Introduction - Road user, vehicle and traffic characteristics - Speed and volume studies - Principles of design of at-grade intersections - Simple layouts - Objectives, classification and uses of traffic signs and road markings.Classification of transport technologies-intermodal co-ordination - ITS and automated highways.

TEXTBOOKS:

1. *Khanna S K and Justo C E G., "Highway Engineering", Nem Chand and Bros, 2011.*
2. *Kadiyali, L. R., "Traffic Engineering and Transportation Planning", Khanna, Publishers, 2008.*

REFERENCE BOOKS:

1. *Papacostas, C S, and Prevedouros. P. D, "Transportation Engineering and Planning", Prentice Hall, 2009.*
2. *Chandola, S. P., "A Text Book of Transportation Engineering", S Chand & Co. Ltd., 2001.*

15CVL314 WATER RESOURCES AND IRRIGATION ENGINEERING 3 1 0 4

Unit 1

Introduction - hydrologic cycle – catchment - stream patterns - description of the basin - hydrometeorology - constituents and vertical structure of atmosphere - general circulation - transitory systems - meteorological observations - formation of precipitation, types of precipitation, forms of precipitation, climate and weather seasons in India, rainfall variations, measurement, presentation of rainfall data, mean precipitation, abstractions from precipitation, evapotranspiration, runoff, hydrograph – concepts, assumptions and limitations of unit hydrograph. Ground water - aquifer types - flow of ground water – well hydraulics - types of wells - other sources of ground water. Irrigation - total planning concept - water requirements of crops - command area – duty-delta. Irrigation efficiency - irrigation requirement of crops.

Unit 2

Reservoir planning - site investigation - zones of storage - Reservoir yield - Estimation of Reservoir Capacity - Reservoir Sedimentation - Reservoir losses and control - Life of Reservoir.

Diversion headworks - Types of diversion works - location of canal headworks - components of headworks - weir and barrages – causes of failure of weirs on permeable foundation and their remedies - criteria for the design of weirs and barrages – Design of impervious floor for subsurface flow - Bligh's creep theory – Khosla's theory design procedure.

Dams - Types of dams and their selection - Gravity dam, arch dam, buttress dam, earth dams. Gravity dam - analysis and design. Spillways - Different types and suitability – Energy dissipation structures below spillway.

Unit 3

Canal Regulation structures - intake structures, canal falls - canal regulators - canal escapes - Tank irrigation - Surplussing arrangements in minor irrigation tanks - Metering flumes - canal outlets – outlet works through dams and river intakes - cross drainage works-types and selection of type of cross drainage works.

Design and detailing of surplus weir, canal regulator and canal drop.

TEXTBOOKS

1. *Garg, S. K., "Irrigation Engineering and Hydraulic Structures", Khanna Publishers, 2006.*
2. *P. N Modi, Irrigation, Water Resources, and Water power Engineering, Standard Book House, 2014.*

REFERENCES:

1. *Linsley. R. K.et.al., Water Resources Engineering, McGraw-Hill International Edition, 1996.*
2. *Ven Te Chow et.al, Applied Hydrology, McGraw Hill Book Co, New York, 1988.*
3. *K. Subramanya, Engineering Hydrology, Tata McGraw - hill publishers, New Delhi, 2008.*
4. *Mays. L. W. Water Resources Handbook, McGraw – Hill International Edition, 1996*
5. *Singh V. P, Elementary hydrology, Prentice Hall, Englewood Cliffs, New Jersey, 1992.*

15CVL381 BUILDING DRAWING 1 0 2 2

Part A

Detailed drawing of components

- Footings
- Roof trusses
- Reinforced Concrete staircase

From given line sketch and specification, develop working drawings of:

- Single storied residential building with flat and tiled roof
- Public buildings like office, dispensary, post office, bank etc.
- Factory building with trusses

Part B (Computer aided drafting)

Preparation of drawings as per building development rules.

- Residential building- flat and pitched roof, economic domestic units, cottages, bungalows
- Public building – small public utility shelters, dispensaries, banks, schools, offices, libraries, hostels, restaurants, commercial complexes, factories etc.
- Preparation of site plans and service plans as per Building Rules.

TEXTBOOKS:

1. *Balagopal T S Prabhu, "Building Design and Civil Engineering Drawing", Spades Publishers, 2008.*
2. *Shaw, Kale and Patki, "Building Drawing", Tata McGraw Hill, 2009.*

REFERENCE BOOKS:

1. *SP 7: 2005, National Building Code of India.*
2. *G. Muthu Shoba Mohan, "Principles of Architecture", Oxford University Press, 2006.*
3. *Crosbie, M. J. And Callender, J. H., "Time-Saver Standards for Architectural Design Data", McGraw Hill, 1997.*
4. *Sham Tickoo, "Autodesk Revit architecture 2010 for architects and building designers", Dreamtech Press, 2010.*

15CVL382 GEOTECHNICAL ENGINEERING LAB. 0 0 2 1

1. Specific gravity of coarse and fine-grained soils
2. Grain size analysis
3. Atterberg's limits and indices
4. Determination of field density (a) sand replacement method (b) core cutter method
5. Determination of coefficient of permeability (a) Constant head method; (b) Variable head method
6. Consolidation test
7. Compaction test (a) IS light compaction test (b) IS heavy compaction test
8. California Bearing Ratio test
9. Direct shear test
10. Triaxial shear test
11. Unconfined compressive strength test & Laboratory vane shear test
12. Demonstration of Plate Load & Standard Penetration Tests

15CVL385 ENVIRONMENTAL ENGINEERING LAB. 0 0 2 1

1. Determination of solids (total, dissolved, organic, inorganic and settleable) in water
2. Determination of turbidity and the optimum coagulant dose
3. Determination of alkalinity and pH of water
4. Determination of hardness and chlorides in water
5. Determination of iron and manganese in water
6. Determination of sulphates and sulphides in water
7. Determination of D.O
8. Determination of available chlorine in bleaching powder and the chlorine dose required to treat the given water sample
9. Determination of coliforms in water
10. Determination of B.O.D and C.O.D

REFERENCES:

Standard method for the examination of water and waste water, 2005, APHA, AWWA, WPCF Publication.

15CVL386 ESTIMATION AND VALUATION PRACTICE 1 0 2 2

1. Introduction - Types of estimate - plinth area method - cubic rate method - unit rate method - bay method - approximate quantity from bill method - comparison method - cost from materials and labour - preparation of detailed estimate
2. Preparation of detailed estimate using Centre line method
3. Preparation of detailed estimate using Long wall - short wall method
4. Preparation of detailed estimate for R.C.C Structures.
5. Preparation of detailed estimate for Steel Structures.
6. Preparation of detailed estimate for roads
7. Preparation of detailed estimate for sanitary and water supply works
8. Specifications - Detailed specifications for common building materials and items of work as per I.S specifications - Preparation of conveyance statement - Calculation of quantities of materials for items of work - Analysis of rate for items of works required for civil engineering works - Preparation of abstract of estimate of civil engineering works.
9. Valuation - types of values – concept of time - value of money - sinking fund - years purchase - Depreciation - obsolescence - valuation of real property - valuation of land - lease and lease hold property.

TEXTBOOKS:

1. *Chakraborti, M.,"Estimation, Costing, Specification and Valuation in Civil Engg", Chakraborti, 2008.*
2. *B. N. Dutta "Estimating& Costing in Civil Engineering Theory and Practice", UBS Publishers & Distributors Limited, 2008.*

REFERENCE BOOKS:

1. *Kohli, D. D and Kohli, R. C, "A text book of Estimating and Costing (Civil)", S. Chand & Company Ltd., 2004.*
2. *IS: 1200 – 1974 – Parts 1 to 25, Methods of Measurement of Building and Civil Engineering Works, Bureau of Indian Standards, New Delhi.*
3. *Standard Data Books of Central Public Works Departments and Public Work Department of States.*

15CVL390 / 15CVL490 LIVE-IN-LAB. 3 cr

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or rural sites during the vacations (after fourth semester or sixth semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth or seventh semester. The objectives and projected outcome of the project should be reviewed and approved by the Dept. chairperson and a faculty assigned as the project guide. On completion of the project, the student shall submit a detailed project report. The report shall be evaluated and the students shall appear for a viva-voce test on the project.

15CVL401 CONSTRUCTION MANAGEMENT 3 1 0 4

Unit 1

Construction management environment - Construction activities and sequence.

Construction planning - Network scheduling - Bar chart, linked bar chart, work-breakdown structures, activity-on-arrow diagrams - event based networks. Critical path method. PERT network analysis.

Unit 2

Network compression - Time-cost study. Resource management. Introduction to Precedence networks.

Construction procedure – contracts – types – bidding process – contract conditions - specifications – quality management principles.

Construction safety and Engineering ethics.

Unit 3

Materials management - inventory control.

Transportation model and application for distribution of materials.

Construction equipment - selection factors - planning of equipment – equipment for excavation, transport, hoisting, piling, and concrete construction.

Introduction to project management softwares.

TEXTBOOKS:

1. *Kumar Neeraj Jha, "Construction Project Management", Pearson Education, 2011.*
2. *R. L. Peurifoy and Schexnayder, "Construction Planning, Equipment, and Methods", Tata McGraw Hill, 2010.*

REFERENCE BOOKS:

1. *Gahlot, P. S. and Dhir, B. M.,"Construction Planning and Management", New Age International, 2012.*
2. *Jerome D. Wiest, Ferdinand K. Levy, "A Management guide to PERT / CPM", PHI Learning, 2009.*
3. *L. S. Srinath, "PERT and CPM-Principles and Applications", Affiliated to East West Press, 2001.*
4. *Shrivastava. U. K., 'Construction Planning and Management', Galgothia Publications Pvt. Ltd, New Delhi, 2013.*
5. *Chitkara, K. K. "Construction Project Management - Planning, Scheduling and Control", Tata McGraw-Hill Publishing Co., 2010.*

15CVL402 ENVIRONMENTAL ENGINEERING II 2 1 0 3

Unit 1

Domestic Waste Water System: Importance and scope of sanitary engineering – Sewerage system – classification– relative merits and situations for adoption. Sources of wastewater – Quantity - fluctuations in flow and their significance. Storm runoff estimation. Factors affecting storm water drainage – empirical and rational methods – time of concentration.

Waste Water Pipe Hydraulics: Hydraulics of waste water flow – Hydraulic element charts – Design Criteria – construction procedure – Testing and maintenance – Shapes and materials of sewers – Sewer appurtenances – Design of storm water line – surface drains for storm water.

Characteristics: Wastewater characteristics and significance – Decomposition – cycles of decomposition – Dissolved oxygen – Biochemical Oxygen Demand – Formulation – Test for 5 day BOD – significance and limitations – Relative stability – Sewage sampling – population equivalent of industrial effluents – Effluent disposal standards.

Unit 2

Waste Water Treatment – Primary Treatments: Objectives – Selection of unit operation and process – Principle and Design of Preliminary Treatments: Screens, skimming tank – types, grease traps – grit chamber - proportional flow weir – Principle and Design of Primary Treatments settling tanks – Types – Design of sedimentation tanks.

Secondary Treatment Processes: Biological process – object, principles of action – Suspended culture systems – Attached culture systems – Activated sludge process and its types – Design of conventional activated sludge process – Oxidation / stabilization ponds – aerobic and facultative ponds, Trickling Filters (conventional and high rate) .

Sludge characteristics – Weight volume relationship, sludge conditioning, dewatering, sludge digestion – process and parameters. Design and Drawing (Detailed sketch) of Septic Tank, IS Code provisions – Methods of septic tank effluent disposal – Testing soil permeability for determination of area.

Unit 3

Disposal of Waste Water: Disposal on water – conditions favoring – standards and criteria for dilution – pollution and self-purification of streams – oxygen sag curve and stages of self-purification – Disposal on land – criteria methods of broad irrigation – subsurface irrigation – sewage sickness of soil.

Solid Waste Management: Solid waste management – causes, effects and control measures of urban and industrial wastes.

Sustainable Development: Sustainable development – Environmental Protection Acts – Introduction to EIA and ISO 14000.

TEXTBOOK:

Birdie G. S and Birdie J. S, "Water Supply and Sanitary Engineering", Dhanpat Rai & Sons, 2010.

REFERENCE BOOKS:

1. *Garg S. K, "Environmental Engineering", Vol. II, Khanna Publishers, 2004.*
2. *Duggal, K. N., "Elements of Environmental Engineering", S Chand & Co. Ltd., 2007.*
3. *Mark J. Hammer and Mark J. Hammer Jr., "Water and Waste Water Technology", Prentice Hall of India Pvt. Ltd., 2008.*
4. *Metcalf and Eddy, "Waste Water Engineering Treatment, Disposal & Reuse", Tata McGraw Hill, 2003.*

15CVL403 TRANSPORTATION ENGINEERING II 2 1 0 3

Unit 1

Railway Engineering: Components and Geometrical Design of Railways – Horizontal Curves, Radius, Super elevation, Cant Deficiency, Transitional Curves, Different types of Gradients, Grade Compensation, Points and Crossings and their Design; Signaling & Interlocking; Layout of Railway Station and Yards.

Unit 2

Tunnel Engineering: Tunnel Alignment and Grade, Size and Shape of Tunnels, Tunneling methods in Soft Soils and Hard Rocks – Modern methods and equipment for tunneling; Ventilation of Tunnels; Lining of Tunnels.

Airport Engineering: Location and Spacing of Airports; Geometrical Design Considerations – Taxiways, Runways and Aprons; Runway Orientation – Wind rose Diagram; Terminal Area Planning, Airport Drainage.

Unit 3

Docks and Harbour Engineering: Definition of Terms; Basic Planning Principles; General Layout and Basic Operational Aspects, Requirements and Classification of Harbours, Ports and Docks; Navigational Facilities; Inland Water Transport.

TEXTBOOKS:

1. *Satish Chandra and M. M Agarwal, "Railway Engineering", Oxford university Press, 2009.*
2. *Rangwala, "Airport Engineering", Charotar Publishing House, 2011.*

REFERENCE BOOKS:

1. *Arora and Saxena, "Railway Engineering", Dhanpat Rai Publications, 2011.*

2. *R Srinivasan, "Harbour, Dock and Tunnel Engineering", Charotar Publishing House, 2012.*
3. *Dr. S. Seetharaman, "Tunnel and Airport Engineering", Umesh Publications, 2012.*
4. *Khanna S K, Arora, M G and Jain S S., "Airport Planning and Design", Nem Chand and Bros, 2009.*
5. *Chandola, S. P., "A Text Book of Transportation Engineering", S. Chand & Co., 2001.*
6. *Subramanian, K. P., "Highway, Railway, Airport and Harbour Engineering, Scitech Publications, 2010.*
7. *Oza, H. P and Oza, G. H., "Dock and Harbour Engineering", Charotar Book House, 2011.*

15CVL430 ADVANCED CONCRETE DESIGN 2 1 0 3

Unit 1

Yield line theory for slabs - Basic principles - methods of yield line analysis.

Deep beams - analysis - design as per BIS - design using strut and tie method.

Chimneys: Analysis of stresses in concrete chimneys - uncracked and cracked sections - codal provisions - design of chimney.

Unit 2

Large span concrete roofs: Introduction – classification - behaviour of flat slabs - direct design and equivalent frame method - codal provisions - waffle slabs.

Shells and Folded plates: Forms of shells and folded plates - structural behaviour of cylindrical shell and folded plate - method of analysis - membrane analysis – beam arch approximation - codal provisions - design of simply supported circular cylindrical long shells and folded plates.

Unit 3

Bridges: General – IRC Bridge code – loading standards – impact effect – wind load – longitudinal forces – centrifugal forces – force due to water currents – buoyancy effect – temperature effects – secondary stresses – erection – seismic force.

Design of slab culvert – R.C box culverts – T-beam bridges – Concept on design of continuous bridges, balanced cantilever bridges, arch bridges and rigid frame bridges.

TEXTBOOKS:

1. *N. Krishnaraju, "Advanced Reinforced Concrete Design", CBS Publisher, 2013.*
2. *M. L. Gambhir, "Design of Reinforced Concrete Structures", PHI Learning, 2009.*

REFERENCE BOOKS:

1. *Varghese P.C., "Advanced Reinforced Concrete Design", PHI, 2009.*

2. Jaikrishna, "Plain & Reinforced Concrete - Vol. I & II", Nem Chand & Bros., 2008.
3. Purushothaman. P, "Reinforced Concrete Structural Elements", Tata McGraw Hill, 1984.
4. G. S. Ramaswamy, "Design and Construction of Concrete Shell Roofs", CBS Publishers, 2005.
5. Ashok K Jain, "Reinforced Concrete – Limit State Design", Nem Chand & Bros., 2012.
6. Pillai S.U and Menon D, "Reinforced Concrete Design" Tata McGraw Hill, 2009.
7. Nilson. A. H., "Design of Concrete Structures", Tata McGraw Hill, 2005.
8. BIS codes (IS 456, IS 2210, IS 4998, IS 3370, SP 16, SP 24, SP 34).
9. IRC Codes (IRC 5, IRC 6, IRC 21)

15CVL431 ADVANCED MECHANICS OF MATERIALS 2 1 0 3

Unit 1

Stress at a point – stress on an arbitrarily oriented plane - stress transformations - strain theory – principal stresses & strains (2D& 3D) - Generalized Hooke's law - Equations of thermo-elasticity for isotropic materials - strain energy density - stress concentration.

Failure & Failure criteria: Modes of failure – yield failure criteria - introduction to fracture mechanics - cracks & brittle fracture – fatigue - elastic and inelastic buckling.

Unit 2

Beams on elastic foundation: Basic equations - Winkler foundations - semi-infinite beams with concentrated loads – infinite beams with concentrated loads - uniformly distributed load - beams of finite length.

Curved Beams: Circumferential stresses - radial stress and shear stress in curved beams - sections having thinflanges - closed sections with thin walls - deflections of sharply curved beams.

Unit 3

Displacements - strains and compatibility - equilibrium equations and boundary conditions – stressfield solutions for plane stress problems - polynomial solutions in Cartesian coordinates – displacements calculated from stresses - plane stress problems in polar coordinates.

TEXTBOOK:

1. A. P. Boresi and O. M. Sidebottom, "Advanced Mechanics of Materials", Wiley, 2009.
2. Budynas, R. G., "Advanced Strength and Applied Stress Analysis", Tata McGraw Hill, 2011.

REFERENCE BOOKS:

1. Timoshenko S. P and Goodier J. N, "Theory of Elasticity", Tata McGraw Hill, 2010.
2. Srinath L. S, "Advanced Mechanics of Solids", Tata McGraw Hill, 2008.

3. S P Timoshenko,"Strength of Materials - Part 2" CBS Publishers & Distributors; Third edition, 1956.
4. R. D. Cook and W. C. Young, "Advanced Mechanics of Materials", Prentice Hall, 1999.

15CVL432 ADVANCED STEEL DESIGN 2 1 0 3

Unit 1

Gantry Girder - Design of gantry girder – gantry to column connection.

Water Tanks - Design of rectangular, pressed steel tanks – design of suspended bottom tanks – cylindrical tank with hemispherical bottom – design of staging.

Chimneys - Design of self-supporting chimney – design principles of guyed chimney.

Bunkers, Silos – Introduction – Janssen's theory – Airy's theory – design criteria.

Unit 2

Transmission Towers – Introduction – loads on towers – analysis – design of members and foundation.

Light gauge members – Light gauge sections – design considerations – allowable stresses – buckling, design of compression members, tension members and laterally supported beams – connections.

Unit 3

Plate girder bridges - Plate girders – loads – equivalent uniformly distributed loads – Indian railway code of practice – design of plate girder bridges – bearings.

REFERENCE BOOKS:

1. Duggal, S. K., "Limit State Design of Steel Structures", Tata McGraw Hill, 2010.
2. Ramchandra and Gehlot, "Limit State Design of Steel Structures", Scientific Publishers, 2010.
3. N. Subramanian, "Design of Steel Structures", Oxford University Press, 2008.
4. G. W. Owens and P. R. Knowles, "Steel Designers' Manual", John Wiley & Sons, 2012
5. P. Dayaratnam, "Design of Steel Structures", S. Chand & Co., 2003.
6. M. Raghupathi, "Design of Steel Structures", Tata McGraw Hill, 1985.
7. Murthy and Santhakumar, "Transmission Line Structures", McGraw Hill, 1990.
8. Lin and Breslar, "Design of Steel Structures", John Wiley & Sons, 1968.
9. BIS codes (IS 800, SP 6,IS 804, IS 805, IS 6533, IS 9178, IS 801,IS 811)

15CVL433 BRIDGE ENGINEERING 2 1 0 3

Unit 1

Investigations for culverts and minor bridges, Investigations for major bridges -

topography, catchment, hydrology, geotechnical aspects, construction resources - design flood discharge - methods, linear waterway. choice of foundation for piers and abutments - types - cost ratio - clearance - choice of foundation - open, pile, well, block foundations - relative suitability. setting out for piers and abutments for minor and major bridges. classification of culverts and bridges - components of bridge structures - loading standards - railway and road loading standards. Types of foundations.

Unit 2

Piers and abutments - function, aesthetics, materials; wing walls - construction aspects. super structure - types - choice of materials - design principles, considerations and criteria of pipe culverts, slab culvert, box culvert, causeways.

Design of T beam and slab bridge - design principles of RC balanced cantilever bridge and articulation. Design concepts of rigid frame bridges - thumb rule design of masonry arch bridges - design of bowstring girder bridge and components.

Unit 3

Suspension bridges, cable stayed bridges and their components; bearings - types - design of rocker and roller bearings.

Bridge superstructure construction - supports and centering for RC bridges - erection of precast RC girders and steel girder bridges - maintenance of bridges, strengthening of masonry arch bridges.

TEXTBOOKS:

1. *D. Johnson Victor, "Essentials of bridge engineering", Oxford University Press, 2008.*
2. *N. Krishna Raju, "Design of bridges", Oxford University Press, 2008.*

REFERENCE BOOKS:

1. *E. J. O'Brien and D. L. Keogh, "Bridge deck analysis", Spons Architecture, 1999.*
2. *Raina, V. K. "Concrete Bridge Practice", Shroff Pub & Dist. Pvt. Ltd, 2007.*
3. *Ponnuswamy, S., "Bridge Engineering", Tata McGraw Hill Education, 2007.*
4. *Relevant Codes of Practice*

15CVL434 COMPUTER METHODS OF STRUCTURAL ANALYSIS 2 1 0 3

Unit 1

Force and Displacement measurement - generalized or independent measurements - constrained or dependent measurements - n dimensional space - principle of superposition - methods of structural analysis. Structure with single and two coordinates - flexibility and stiffness matrices in n coordinates – examples - symmetric nature - constrained measurements - stiffness and flexibility matrices of the element as well as the system - computing the influence coefficient.

Strain energy in terms of stiffness and flexibility matrices - interpretation of coefficient - Betti's law - other energy theorems using matrix notation.

Unit 2

Flexibility and Stiffness Methods (Element Approach): Choice of redundant - ill and well condition equation - Transformation Matrices - transformation of one set redundant to other set - thermal expansion - lack of fit – application to pin-jointed plane truss - continuous beams, frames and grids.

Development of stiffness method - analogy between flexibility and stiffness - analysis due to thermal expansion, lack of fit - Stiffness matrix with rigid body motion - application to pin jointed plane and space trusses - continuous beams - frames and grids - static condensation techniques. Problem solving by computer - choice of the method.

Unit 3

Introduction to Finite Element Method: Basic concepts - Rayleigh-Ritz Method - Finite difference method – Variational principles - MWR (theory only) - Steps in finite element method - Axial element force formulation by displacement method only - Theory of stress model -Displacement model - Hybrid models.

Analysis and Design of Pin-jointed and Rigid-jointed Framed Structures using STADD pro (2D and 3D), Introduction to SAP, ETABS, ABAQUS.

TEXTBOOKS:

1. *Rajasekaran S, Sankara Subramanian G, "Computational Structural Mechanics", Prentice-Hall of India Pvt, 2006.*
2. *Krishnamoorthy C. S., Rajeev S., "Computer Aided Design", Narosa Publishing House, New Delhi, 1991.*

REFERENCE BOOKS:

1. *Wang. C. K., "Intermediate Structural Analysis", Tata McGraw Hill, 1983.*
2. *Timoshenko and Young, "Theory of Structures", McGraw Hill, 1965.*
3. *Kanchi. M. B., "Matrix Methods of Structural Analysis", New Age International, 1993.*
4. *Reddy. J. N., "An introduction to finite element method", Tata McGraw Hill, 2005.*

15CVL435 FINITE ELEMENT METHODS 2 1 0 3

Unit 1

Boundary value problems and the need for numerical discretization: Introduction, examples of continuum problems, history of finite element method.

Weighted residual methods: Approximation by trial functions, weighted residual forms, piecewise trial functions, weak formulation, Galerkin method, examples of one-, two- and three-dimensional problems.

Variational methods: Variational principles, establishment of natural variational principles, approximate solution of differential equations by Rayleigh-Ritz method, the use of Lagrange multipliers, general variational principles, penalty functions, least-square method.

Unit 2

Isoparametric formulation: The concept of mapping, isoparametric formulation, numerical integration, mapping and its use in mesh generation.

Higher order finite element approximation: Degree of polynomial in trial functions and rate of convergence, the patch test, shape functions for C0 and C1 continuity, one-, two- and three-dimensional shape functions.

Unit 3

Coordinate Transformation: Transformation of vectors and tensors, transformation of stiffness matrices, degree of freedom within elements, condensation, condensation and recovery algorithm, substructuring, structural symmetry.

Formulation of stiffness matrix, member approach for truss and beam element, node numbering, assembly of element equations, formation of overall banded matrix equation, boundary conditions and solution for primary unknowns, Equilibrium and compatibility in solution- applications to truss and beam.

TEXTBOOKS:

1. *Rao, S. S., "Finite Element Method in Engineering", Elsevier, 2011.*
2. *Reddy, J. N., "An Introduction to the Finite Element Method", Tata McGraw Hill, 2005.*

REFERENCE BOOKS:

1. *Bathe K. J., "Finite Element Procedures in Engineering Analysis", Prentice Hall of India, 1996.*
2. *Cook R. D., Malkus D. S., Plesha M. F., and Witt R. J., "Concepts & Applications of Finite Element Analysis", Wiley India, 2007.*
3. *Chandrupatla T. R. and Belegundu A. D., "Introduction to Finite Elements in Engineering", Prentice Hall of India, 2007.*
4. *Zienkiewics O. C., Taylor R. L. and Zhu, J. Z., "The Finite Element Method: Its Basis and Fundamentals", Butterworth-Heinemann, 2005.*

15CVL436 INDUSTRIAL STRUCTURES 2 1 0 3

Unit 1

Functional design of industrial buildings:
Classification of industrial structures - layout planning requirements – Guidelines from factories act – Lighting - Illumination levels – Natural / Mechanical ventilation – Fire safety requirements – Corrosion protection – Protection against noise – Cladding systems - vibration isolation techniques - Industrial floors.

General overview of Thermal power plant / Nuclear power plant structures / Process plant steelwork – conveyor structures – Boiler supporting structures - Substation structures.

Unit 2

Braced Industrial buildings – Unbraced Industrial frames – Gantry girders – Design of steel beam connections - Flexible & Rigid (Bolted and welded types).

Machine foundations – Types - Design Requirements - Analysis and design of block type machine foundations (IS 2974 method).

Unit 3

Design of Reinforced concrete bunkers and silos as per IS:4995

Tall Chimneys (RCC) – Types - Chimney sizing parameters - Overview of wind and temperature effects - Design principles of Reinforced concrete chimneys as per IS:4998.

Cooling Towers – Types and functions - Design principles of RC natural draught cooling towers as per IS:11504.

REFERENCE BOOKS:

1. *S. N. Manohar, "Tall Chimneys: Design and Construction", Tata McGraw Hill, 1985.*
2. *P. Dayaratnam, "Design of Steel Structures", S. Chand & Co., 2003.*
3. *Ramchandra and Gehlot, "Limit State Design of Steel Structures", Scientific Publishers, 2010.*
4. *P. Srinivasulu and G. V. Vaidyanathan, "Handbook of Machine Foundations", Tata McGraw Hill, 2004.*
5. *SP: 32–1986, "Hand Book on Functional Requirements of Industrial Buildings (Lighting and ventilation)".*
6. *G. W. Owens and P. R. Knowles, "Steel Designers' Manual", John Wiley & Sons, 2012.*
7. *V. Kalayanaraman (editor), "Advances in Steel Structures", Tata McGraw Hill, 1990.*
8. *Krishnaraju N., "Advanced Reinforced Concrete Design", CBS Publishers, 2013.*
9. *K. K. McKelvey and Maxey Brooke, "The Industrial Cooling Tower", Elsevier Publishing Co., 1959.*

15CVL437 SMART MATERIALS AND STRUCTURES 2 1 0 3

Unit 1

Introduction to Smart Materials and Structures – Instrumented structures functions and response – Sensing systems – Self-diagnosis – Signal processing consideration – Actuation systems and effectors.

Measuring techniques: Strain Measuring Techniques using Electrical strain gauges, Types – Resistance – Capacitance – Inductance – Wheatstone bridges – Pressure transducers – Load cells – Temperature Compensation – Strain Rosettes.

Unit 2

Sensing Technology – Types of Sensors – Physical Measurement using Piezo Electric Strain measurement – Inductively Read Transducers – The LVDT – Fiber optic Techniques.

Chemical and Bio-Chemical sensing in structural Assessment – Absorptive chemical sensors – Spectroscopes – Fibre Optic Chemical Sensing Systems and Distributed measurement.

Unit 3

Actuator Techniques – Actuator and actuator materials – Piezoelectric and Electrostrictive Material – Magneto structure Material – Shape Memory Alloys – Electro rheological fluids – Electromagnetic actuation – Role of actuators and Actuator Materials.

Data Acquisition and Processing – Signal Processing and Control for Smart Structures – Sensors as Geometrical Processors – Signal Processing – Control System – Linear and Non-Linear.

REFERENCE BOOKS:

1. *Srinivasan, A. V. and Michael McFarland, D., "Smart Structures: Analysis and Design", Cambridge University Press, 2009.*
2. *Michelle Addington and Daniel L. Schodek, "Smart Materials and Technologies: For the Architecture and Design Professions", Routledge 2004.*
3. *Brain Culshaw, "Smart Structure and Materials", Artech House – Borton. London,1996.*
4. *L. S. Srinath, "Experimental Stress Analysis", Tata McGraw-Hill, 1998.*
5. *J. W. Dally and W. F. Riley, "Experimental Stress Analysis", Tata McGraw-Hill, 1998.*

15CVL438 STRUCTURAL DYNAMICS AND SEISMIC DESIGN 2 1 0 3

Unit 1

Introduction to structural dynamics – importance of structural dynamics - types and sources of dynamic loads - distinguishing features of a dynamic problem – methodology for dynamic analysis – types of structural vibration - basic terminology.

Single Degree of Freedom: Linear systems: Equation of motion - components of vibration system - natural frequency - viscous damping - response to undamped and damped free and forced vibration - response to support motion – principle of accelerometers and displacement meters.

Unit 2

Two Degrees of Freedom: Equations of motion - Eigen value problem - free vibration

response – forced vibration response to harmonic excitation - response to support motion - modal analysis.

Earthquake Resistant Design: Elements of Engineering Seismology - Indian Seismicity – faults – seismic waves – earthquake intensity and magnitude – earthquake ground motion - behaviour of structures in the past Earthquakes – basic terminology.

Earthquake Response: Linear systems: Earthquake ground motion – response spectrum - response history analysis

Unit 3

IS codal provisions for the determination of lateral loads – modal analysis. Soil liquefaction – soil-structure interaction effects.

Design Concepts: Seismic Design Concepts - design spectrum - Earthquake Resistant Design of simple framed structures – IS:1893 codal provisions - ductile detailing of Reinforced Concrete frames as per IS:13920.

TEXTBOOKS:

1. *Mario Paz, "Structural Dynamics", Springer, 2007.*
2. *Pankaj Agarwal, Manish Shrikhande, "Earthquake Resistant Design of Structures", PHI Learning, 2009.*

REFERENCE BOOKS:

1. *Anil K Chopra, "Dynamics of Structures: Theory and Applications to Earthquake Engineering", Pearson Education, 2008.*
2. *Duggal.S. K., "Earthquake Resistant Design of Structures", Oxford University Press, 2013.*
3. *IS:1893 - (Part I), Criteria for Earthquake Resistant structures - General Provisions and Buildings*
4. *IS:13935 – Repair and Seismic strengthening of buildings*
5. *IS:4326 - Earthquake Resistant Design and Constructions of buildings*
6. *IS:13920 – Ductile detailing of RC Structures subject to Seismic forces*

15CVL440 ADVANCED SURVEYING 2 1 0 3

Unit 1

Field astronomy - definitions - solution of an astronomical triangle - co-ordinate systems - time - solar, siderial and standard equation of time - sundial - determination of time, azimuth, latitude and longitude. Map Projection: introduction - methods of projection.

Unit 2

Electronic distance measurement – principle – reduction of E.D.M lines - geodimeter – tellurimeter - total station – global positioning system.

Photogrammetry – terrestrial and aerial photogrammetry – heights and distances fromphotographs – flight planning – elements of stereoscopy – photo mosaic – photo interpretation – applications of photogrammetry.

Unit 3

Remote sensing – introduction – electromagnetic radiation – target interactions – remote sensing systems – remote sensing from space – applications of remote sensing.

TEXTBOOKS:

1. *Agor, R. A, "Textbook of Advanced Surveying", Khanna Publishers, 2002.*
2. *Punmia. B. C., "Higher Surveying", Laxmi Publications, 2006.*

REFERENCE BOOKS:

1. *Joshi M. D. and Jawaharlal Sharma, "Text Book of Advanced Surveying", CBS Publishers, 1985.*
2. *Arora K. R., "Surveying – Vol. III", Standard Publishers, 1993*
3. *Ram Pal K. K. "Text Book of Photogrammetry", Oxford & IBH Publishers, 1982.*
4. *Duggal, S. K, "Surveying Vol.II", McGraw Hill Education, 2013.*

15CVL441 ARCHITECTURAL SCIENCE 2 1 0 3

Unit 1

Principles of architectural design: Factors influencing architectural development – characteristic features of style – historic examples – creative principles. Principles of architectural composition – Unity – balance – proportion – scale – rhythm – harmony – Accentuation and contrast.

Organising principles in architecture – Symmetry – hierarchy – axis – linear – concentric, radial – and asymmetric grouping – primary and secondary masses. Role of colour, texture, shapes/ forms in architecture.

Architectural space and mass, visual and emotional effects of geometric forms; activity space and tolerance space. Forms related to materials and structural systems. Architecture as part of the environment.

Unit 2

The Thermal Environment: Climatic elements: climate graph – comparison and classification of climates. Earth's thermal balance. Thermal balance of human body – thermal comfort indices – comfort zone.

Thermo physical properties of building materials: resistance and transmittance – sol- air temperature - solar gain factor. Heat flow through buildings – thermal transmittance of structural elements - periodic heat flow.

Design criteria for control of climate – passive and active building design – passive approach. Active systems – low energy cooling.

Unit 3

The Luminous Environment: Types of visual tasks – principles of day lighting – evaluation of lighting by windows, skylights – artificial lighting – illumination requirements – lamps and luminaries – coefficient of utilisation – flood lighting of building exteriors.

The Sonic Environment: Physics of sound – airborne and structure borne propagation – behavior of sound in free field and enclosures – design criteria for spaces – acoustical defects – sound reduction, sound insulation and reverberation control.

TEXTBOOKS:

1. *Francis D. K. Ching., "Architecture – Form, Space and Order", John Wiley & Sons, Inc., 2007*
2. *Steven V. Szokolay., "Introduction to Architectural Science - The Basis of Sustainable Design", Elsevier, 2007.*

REFERENCE BOOKS:

1. *Muthu Shobha Mohan, "Principles of architecture", Oxford University Press, 2006.*
2. *Koenigseberger, "Manual of Tropical housing and Building – Climatic Design", Universities Press, 2010.*
3. *Bureau of Indian standards, Handbook on Functional Requirement of Buildings – SP:41(S and T) – 1987*
4. *Narasimham V., "An Introduction to Building Physics", Kabeer Printing Works, Chennai, 1974.*
5. *Krishnan, "Climate Responsive Architecture", Tata McGraw Hill, 1999.*

15CVL442 CONCRETE TECHNOLOGY 2 1 0 3

Unit 1

Materials: cement - different types - chemical composition and physical properties - tests on cement - I.S. specifications - aggregates - classification - mechanical properties and tests as per I.S. - alkali aggregate reaction - grading requirements - heavy weight - light weight - normal weight - aggregate - sampling of aggregate - water - quality of water - admixtures - accelerators - retarders - water reducing agents – super plasticizers- use of silica fumes.

Properties of fresh concrete - workability - factors affecting workability - tests for workability - segregation and bleeding.

Unit 2

Properties of hardened concrete - factors affecting strength of concrete - strength of concrete in compression, tension and flexure - stress- strain characteristics and elastic properties - shrinkage and creep - durability of concrete - permeability - chemical attack - sulphate attack - resistance to abrasion and cavitation - resistance

to freezing and thawing - resistance to fire - marine atmosphere - quality control - frequency of sampling - test specimens - statistical analysis of test results - standard deviation - acceptance criteria.

Manufacture of concrete - measurement of materials - storage and handling - batching plant and equipment - mixing - types of mixers - transportation of concrete - pumping of concrete - placing of concrete - under water concreting - compaction of concrete - curing of concrete - ready mix concrete.

Unit 3

Mix proportioning - nominal mixes - design mixes - factors influencing mix design - A.C.I method - I.S method - design for high strength mixes.

Special concretes - lightweight concrete - high density concrete - vacuum concrete - shotcrete - Fibre reinforced concrete - polymer concrete - ferrocement - high performance concrete - self compacting concrete.

Introduction to Non-destructive test methods.

TEXTBOOKS:

1. *Neville. A. M. and Brooks. J. J., "Concrete Technology", Pearson Education, 2004*
2. *Santha Kumar, A. R., "Concrete Technology", Oxford University Press, 2006.*

REFERENCE BOOKS:

1. *Mehta, P. K. And Monteiro, P. J. M., "Concrete - Microstructure, Properties and Materials", Tata McGraw Hill Edition, 2006.*
2. *Shetty, M. S, "Concrete Technology -Theory and Practice", S. Chand & Co., New Delhi, 2009.*
3. *A. M. Neville, "Properties of Concrete", Pearson Education, 2008.*

15CVL443 CONSTRUCTION ECONOMICS AND FINANCE 2 1 0 3

Unit 1

Engineering economics: Basic principles – Time value of money, Quantifying alternatives for decision making, Cash flow diagrams, Equivalence - Single payment in the future (P/F, F/P), Present payment compared to uniform series payments (P/A, A/P), Future payment compared to uniform series payments (F/A, A/F), Arithmetic gradient, Geometric gradient.

Unit 2

Comparison of alternatives: Present, future and annual worth method of comparing alternatives, Rate of return, Incremental rate of return, Break-even comparisons, Capitalized cost analysis, Benefit-cost analysis.

Depreciation, Inflation and Taxes.

Equipment economics: Equipment costs, Ownership and operating costs, Buy/Rent/Lease options, Replacement analysis.

Unit 3

Cost estimating: Types of Estimates, Approximate estimates – Unit estimate, Factor estimate, Cost indexes, Parametric estimate, Life cycle cost.

Financial management: Construction accounting, Chart of Accounts, Financial statements – Profit and loss, Balance sheets, Financial ratios, Working capital management.

TEXTBOOKS:

1. *Bose, D. C., "Fundamentals of Financial management", 2nd ed., PHI, New Delhi, 2010.*
2. *Prasanna Chandra, "Projects: Planning, Analysis, Selection, Financing, Implementation and Review", Tata McGraw - Hill Education, 2009*

REFERENCE BOOKS:

1. *Gould, F. E., "Managing the Construction Process", 4th ed., Pearson Education, 2012.*
2. *Harris, F., McCaffer, R. and Edum-Fotwe, F., "Modern Construction Management", 6th ed., Wiley India, New Delhi, 2006.*
3. *Jha, K. N., "Construction Project Management, Theory and Practice", Pearson, New Delhi, 2011.*
4. *Peurifoy, R. L. and Oberlender, G. D., "Estimating Construction Costs", 5th ed., Tata McGraw-Hill, New Delhi, 2004.*

15CVL444 DISTRESS MONITORING AND REPAIR OF STRUCTURES 2 1 0 3

Unit 1

Durability: Life expectancy of different types of buildings – influence of environmental elements such as heat, moisture, precipitation and frost on buildings- Effect of biological agents like fungus, moss, plants, trees, algae - termite control and prevention - chemical attack and impact of pollution on building materials and components - Aspects of fire damage and assessment.

Unit 2

Building failures – causes and effects - cracks in buildings – types, classification. Investigation and condition assessment – Semi-destructive and Non-destructive testing methods.

Common defects in buildings and control measures - maintenance philosophy - phases of maintenance.

Materials for repair - special mortar and concretes, concrete chemicals, admixtures, special cements and high grade concrete.

Unit 3

Techniques for repair - surface repair – material selection – surface preparation - rust eliminators and polymer coatings for rebars – repair methods of cracks in concrete and masonry - epoxy injection. Guniting and shotcreting. Waterproofing methods.

Strengthening measures - flexural strengthening, beam shear capacity strengthening, column strengthening, shoring, under pinning and jacketing.

Conservation of historic buildings - materials and methods - examples.

TEXTBOOKS:

1. *Peter H. Emmons, "Concrete Repair and Maintenance", Galgotia Publications, 2010.*
2. *Vidivelli. B., "Rehabilitation of Concrete Structures", Standard Publishers, 2009.*

REFERENCE BOOKS:

1. *James Douglas, Bill Ransom, "Understanding Building Failures", Taylor & Francis Group, 2007.*
2. *Philip H. Perkins, "Repair, Protection and Water proofing of Concrete Structures", E & FN Spon, 1997.*
3. *SP:25 - 1984, "Causes and prevention of cracks in buildings", BIS*
4. *Santhakumar A. R., "Concrete Technology", Oxford University Press, 2006.*
5. *Sidney M. Johnson, "Deterioration, Maintenance and Repair of Structures", McGraw Hill, 1965.*
6. *Raikar, "Durable Structures – Through planning for preventive maintenance", R &D Centre, Structural Designers and Consultants Pvt. Ltd. New Bombay, 1994.*
7. *Raikar, "Diagnosis and Treatment of Structures in Distress", R & D Centre, Structural Designers and Consultants Pvt. Ltd., New Bombay, 1994.*

15CVL445 SUSTAINABLE CONSTRUCTION 2 1 0 3

Unit 1

Sustainability in the built environment: sustainable development relative to ecological, economic and social conditions – efforts in sustainable development and construction – international organisations involved. Ethics and sustainability: environmental and resource concerns – resource consumption by construction industry - Green building movement. Ecological design – concept – major contributions. Building assessment and eco labels – standards (LEED, GRIHA) – assessment structure and process. Green building design process – documentation requirements.

Unit 2

Sustainable site and landscape – storm water management, heat island mitigation - assessment of sustainable sites. Building energy issues - building energy design strategy - building envelope – internal load reduction – energy optimisation -

renewable energy systems. Reducing carbon footprint. Built environment hydrologic cycle – water resources issues – strategies for conservation and recycling – waste water and storm water handling strategies. Materials resources - Life cycle assessment – embodied energy – Green building materials and products – assessing for environmental impacts – design for deconstruction – LEED credits for different aspects.

Unit 3

Indoor environmental quality – issues and causes, components of integrated design – emissions from building materials. Construction operations – site planning, indoor air quality during construction – materials management – Construction and Demolition – waste management – building commissioning – LEED credits for different aspects. Green building economics – quantifying benefits. Recent advances in sustainable construction.

TEXTBOOK:

"Sustainable Building Design Manual - Volume II", Published by TERI, New Delhi, 2004.

REFERENCE BOOKS:

1. *Kibert, C. J., "Sustainable Construction: Green Building Design and Delivery", John Wiley & Sons, 2013.*
2. *Steven V. Szokolay., "Introduction to Architectural Science - The Basis of Sustainable Design", Elsevier, 2007.*
3. *Sandy Halliday, "Sustainable Construction", Routledge, (Taylor & Francis Group), 2013.*
4. *Dejan Mumovic and Mat Santamouris (Ed), "A Handbook of Sustainable Building Design and Engineering", Earthscan Publishing, 2009.*
5. *Osman Attmann, "Green Architecture: Advanced Technologies and Materials", McGraw Hill, 2010.*

15CVL450 ADVANCED FOUNDATION ENGINEERING 2 1 0 3

Unit 1

Foundation on expansive soils: Introduction to expansive soil - Clay mineralogy and mechanism of swelling - Identification of expansive soils - Swelling potential, swelling pressure, free swell - Free swell index - Classification of expansive soil - Tests for swell pressure (IS code method) - Prediction of swell pressure from index properties - Damages in buildings on expansive soils - Elimination of swelling - Environmental solutions such as soil replacement techniques and lime columns - Principles of design of foundations in expansive soil deposits - Structural solutions such as provision of rigid foundation, under reamed piles, T Beams as strip footing for walls etc. (basic aspects).

Unit 2

Soil dynamics and Machine foundations: Introduction to soil dynamics - Soil behavior

under dynamic loads - Difference between static and dynamic load behavior of soil - Dynamic soil properties - Free vibrations and forced vibrations - Types of machines - Types of machine foundations - Vibration analysis of a machine foundation - General design criteria for machine foundations - Design criteria for foundation for reciprocating machines (IS specifications) - Design procedure for block foundation for a reciprocating machine (IS code method) - Vibration isolation and control.

Unit 3

Special foundations: Introduction to shell foundations - Structural form and efficiency - Different types of shell foundations - General principles of geotechnical design of shell foundations and soil-structure interaction.

Special features of the foundations for water tanks, silos, chimneys and transmission line towers.

Foundations for marine structures - Design principles.

TEXTBOOKS:

1. *Varghese P. C., "Foundation Engineering", Prentice-Hall of India Private Ltd, 2009.*
2. *Swami saran, "Soil dynamics and Machine Foundations", Galgotias, 2012.*

REFERENCE BOOKS:

1. *Ninan P Kurian, "Design of Foundation Systems", Narosa Publishers, 2009*
2. *Shamsher Prakash, "Soil Dynamics", McGraw Hill, 1981.*
3. *Tomlinson M. J., "Foundation Design & Construction", Prentice-Hall, 2003.*
4. *Joseph E. Bowles, "Foundation Analysis & Design", Tata McGraw Hill, 1996.*
5. *Coduto, "Geotechnical Engineering Principles and Practices", PHI, New Delhi, 2010.*
6. *Srinivasalu and Vaidyanathan, "Handbook of Machine Foundations", Tata McGraw Hill, 2004.*
7. *Swami Saran, "Analysis and Design of Substructures", Oxford & IBH, 2008.*

15CVL451 EARTH RETAINING STRUCTURES 2 1 0 3

Unit 1

Earth dams – types of dams – selection of type of dam based on material availability – foundation conditions and topography. Design details – crest, free board, upstream and downstream slopes, upstream and downstream slope protection – central and inclined cores – types and design of filters. Seepage analysis and control – seepage through dam and foundations – control of seepage in earth dam and foundation. Stability analysis – critical stability conditions – Evaluation of stability by Bishop's and sliding wedge methods under critical conditions.

Unit 2

Construction techniques – methods of construction – quality control. Instrumentation

– measurement of pore pressures. Earth pressure theories – Rankine's and Coulomb's earth pressure theories for cohesionless and cohesive backfills – Computation of earth pressures for various cases – inclined – with surcharge – submerged and partly submerged – stratified backfills.

Rigid retaining structures – active and passive earth pressures against gravity retaining walls – Surcharge - Computation of earth pressures by Trial wedge method – a mathematical approach for completely submerged andpartly submerged backfills – Importance of capillarity tension in earth pressure.

Graphical methods of earth pressure computation – Trial wedge method for coulomb's and Rankine's conditions, for regular and irregular ground and wall conditions – Rebhan's construction for active pressure – Friction circle method – Logarithmic spiral method.

Unit 3

Design of gravity retaining wall – Cantilever retaining walls Flexible retaining structure – type and methods of construction – Design strength parameters – safety factor for sheet pile walls – Computation of earth pressures against cantilever sheet piles in cohesionless and cohesive soils –anchored sheet piles – free earth method – fixed earth method – Rowe's moment reduction method – Stability of sheet piling.

Diaphragm walls and coffer dams – type of diaphragm walls and their construction techniques in various soil types – Earth pressure on braced cuts and coffer dams – Design of coffer dams.

TEXTBOOKS:

1. *Winterkorn H. F. and Fand H. Y., "Foundation Engineering handbook", Galgotia, 2000.*
2. *Clayton C. R. I, Militisky, J and Woods, "Earth Pressure and Earth Retaining Structures", Survey university press, 1993.*

REFERENCE BOOKS:

1. *Das, B. M., "Principles of Foundation Engineering", CL Engineering, 2013.*
2. *Das, B. M., "Fundamentals of Geotechnical Engineering", CL Engineering, 2013.*
3. *Swami Saran, "Analysis and Design of Foundations and Retaining Structures", IK International Publishing, 2012.*

15CVL452 ENVIRONMENTAL GEOTECHNOLOGY 2 1 0 3

Unit 1

Environmental cycles - Soil and water - Environmental interaction relating to geotechnical problems - Effect of pollution on soil - water behaviour.

Origin, nature and distribution of soil - Description of individual particle - Soil fabric and structure - Gravitational and surface forces - Intersheet and interlayer bonding in the clay minerals - Basic structural units of clay minerals - Isomorphous substitution - Kaolinite mineral - Montmorillonite mineral - Illite mineral - Electric charges on clay minerals - Ion exchange capacity - Diffused double layer - Adsorbed water - Soil structure - Methods for the identification of minerals (introduction only).

Effect of drying on Atterberg limits - Shrinkage, swelling and cracking characteristics of soil - Electrochemical characteristics of soil-water system - Sensitivity of soil to environment - Soil-water-air interaction - Activity, sensitivity, causes of sensitivity - Influence of exchangeable cations, pH and organic matter on properties of soils - Permeability of soils - Hydraulic conductivity of different types of soils - Darcy' s law and its validity - Factors affecting permeability

Unit 2

Sources, types and composition of different wastes - Characteristics and classification of hazardous wastes - Generation rates - Potential problems in soils due to contaminants.

Ground water flow - Sources of ground water contamination - Contaminant transport - Pollution of aquifers by mining and liquid wastes - Ground water pollution downstream of landfills - Transport mechanisms.

CPCB rules and regulations on waste handling and management - Criteria for selection of sites for waste disposal - Disposal techniques -Disposal systems for typical wastes.

Ground modification and waste modification techniques in waste management - Ground modification - Mechanical modification, hydraulic modification, chemical modification.

Unit 3

Liners and covers for waste disposal - rigid and flexible liners - Leachate and gas collection system - Engineered landfills (including basal liner and cover liner systems) – components - design criteria.

Hydrological design for ground water pollution control.

Soil contamination and remediation technology for both ground and aquifers.

REFERENCE BOOKS:

1. *Mitchell J. "Fundamentals of soil behaviour", John Wiley and Sons., Third Edition, 2005.*
2. *Robert M. Koerner, "Construction and Geotechnical methods in Foundation Engineering", McGraw Hill Book Co., 1996.*

3. *Abdel M. O. Mohamed and Hogan E. Antia, "Developments in Geotechnical Engineering", Elsevier, 1998.*
4. *Hari D. Sharma and Krishna R. Reddy, "Geoenvironmental Engineering – Site Remediation, Waste Containment, Emerging waste management technologies", John Wiley and sons, 2004.*
5. *Daniel D. E. "Geotechnical Practice for Waste Disposal", Chapman and Hall. 1993.*
6. *Hsai Yang Fang and John Daniel, "Introduction to Environmental Geotechnology", CRC press, Taylor and Francis, Second Edition, 2013.*

15CVL453 GROUND IMPROVEMENT TECHNIQUES 2 1 0 3

Unit 1

Objective of ground improvement - In-situ ground improvement methods - Introduction to soil improvements without the addition of many material - surface compaction – compaction piles in sand - impact compaction / dynamic compaction of sands – vibratory compaction in sand - vibroflotation in sand – explosions in sand - Terra probe method - replacement process - vibroflotation in clays - preloading techniques - sand drains - stone columns - introduction to soil improvement by thermal treatment - introduction to biotechnical stabilization.

Unit 2

Introduction to soil improvement by adding materials - lime stabilization – Mechanism - optimum lime content - lime fixation point - effect of lime on physical and engineering properties of soil - lime column method - stabilization of soft clay or silt with lime – stabilization with cement -suitability for soils - effect on properties of soils. Grouting – types - desirable characteristics of grouts - grouting methods - grouting pressure - grouting materials - grouting technology - permeation grouting - compaction grouting - soil fracture grouting - jet grouting - application and limitations - slab jacking, grouted columns - application to dams.

Unit 3

Soil improvement using reinforcing elements - introduction to reinforced earth - load transfer mechanism and strength development - soil types - reinforcing materials - Reinforced earth retaining walls - reinforced embankments - soil nailing.

Geosynthetics – Types - general applications - types of geotextiles and geo-grids - physical and strength properties of geotextiles and geogrids - behaviour of soils on reinforcing with geotextiles and geogrids - design aspects with geotextiles and geogrid.

TEXTBOOKS:

1. *Purushothama Raj.P., "Ground Improvement Techniques", University Science Press, 2009.*
2. *Swami Saran., "Reinforced soil and its engineering applications", I. K. International Pvt Ltd, 2010*

REFERENCE BOOKS:

1. *Moseley and Kirsch, "Text Book on Ground Improvement", Spon Press, 2004.*
2. *Shashi K. Gulhati and Manoj Dutta, "Geotechnical Engineering", Tata McGraw Hill, 2005.*
3. *Boweven R., "Text Book on Grouting in Engineering Practice", John Wiley and Sons, 1981.*
4. *Jewell R. A., "Soil reinforcement with geotextiles – Special Publication 123", CIRIA Special Publication, Thomas Telford, 1996.*
5. *Donald H. Gray and Robbin B. Sotir, "Text Book on Biotechnical & Soil Engineering Slope Stabilization", Wiley International, 1996.*
6. *Korener, "Construction & Geotechnical Methods in Foundation Engineering", McGraw Hill, 1986.*
7. *Nihar Ranjan Patra, "Ground Improvement Techniques", Vikas Publishing House, 2012.*

15CVL455 GROUND WATER HYDROLOGY 2 1 0 3

Unit 1

Occurrence of ground water: origin - rock properties affecting ground water vertical distribution - geologic formations as aquifers - types of aquifers - aquifer parameters - ground water basins - springs - Laplace equation - potential flow lines - flow net – flownet for anisotropic soils - seepage under a dam - groundwater contours - determination of flow direction - steady unidirectional flows in aquifers - confined and unconfined - aquifer with percolation - steady radial flow towards a well - well in uniform flow - steady flow with uniform discharge - partially penetrating wells - steady flow in leaky aquifer.

Unit 2

Unsteady flow - general equation - Cartesian and polar coordinate - unsteady radial flow in to a well - confined, unconfined and leaky aquifers – multiple well system - pumping tests – non-equilibrium equation for pumping tests - Thies' method - Jacob method - Chow's method - characteristics well losses – step draw down test - well near aquifer boundaries - determination of boundaries from pumping test. Image wellsfor various boundary conditions - Cavity well and open well - yield tests - pumping and recuperation test.

Unit 3

Tube wells: design - screened wells - gravel packed wells - well loss - selection of screen size - yield of a well - test holes - well logs - methods of construction - dug wells - shallow tube wells - deep wells - gravity wells - drilling in rocks - screen installation - well completion - well development - testing wells for yield - collector - or radial wells - infiltration galleries - well point system - failure of tube wells.

Ground water investigation methods.

TEXTBOOKS:

1. *Raghunath, H. M., "Ground Water", New Age International, 2007.*

2. *Karanth, K. "Groundwater Assessment, Development and Management", Tata McGraw Hill, 2003.*

REFERENCE BOOKS:

1. *Todd, D. K. and Mays. L. W., "Ground Water Hydrology", Wiley India, 2011.*
2. *Garg S. P., "Ground Water and Tube wells", Oxford & IBH, 1993.*
3. *Raghunath H. M., "Hydrology: Principles, Analysis and Design", New Age International Publishers, 2006.*

15CVL456 REMOTE SENSING AND GIS 2 1 0 3

Unit 1

Introduction, Basic concepts and principles of remote sensing; Definition components of remote sensing - energy sensor, interacting body – active and passive remote sensing – platforms - EMR interaction with earth surface material, radiance, irradiance, incident, reflected, absorbed and transmitted energy – reflectance – specular and diffused reflection surfaces – spectral signature – spectral signature curves – EMR interaction with water, soil and earth surface. Application; Meteorology, land use, networking, hydrological studies, soil studies and coastal zone analysis.

Unit 2

Photogrammetry; Aerial and Terrestrial; photo interpretation. Sensors; Radar imaging; colour scanners; thematic mapper.

Geographic information system – components of GIS – hardware, software and organisational context – data – spatial and non-spatial maps – types of maps – projection - types of projection – data input - digitiser, scanner, editing – raster and vector data structures – comparison of raster and vector data structure.

Unit 3

Analysis using raster and vector data – retrieval, reclassification, overlaying, buffering - data output – printers and plotters. Open source softwares.

GIS and remote sensing applications – urban applications – water resources – urban analysis – watershed management – resources information system – hazard mitigation.

TEXTBOOKS:

1. *Lillesand, Kiefer and Chipman, "Remote Sensing and Image Interpretation", Wiley student edition, 2013.*
2. *A. M. Chandra and S. K. Gosh, "Remote Sensing and GIS", Alpha Science, 2006.*

REFERENCES:

1. *Anji Reddy, "Remote sensing and Geographical systems", BS Publications, 2012.*

2. L R A Narayana, "Remote Sensing and its applications", Universities Press, 1999
3. J. V. S. Murthy, "Watershed management", New Age International, 1998.
4. Wurbs, R. A., and James, W. P., "Water Resources Engineering". PHI Learning, 2009.
5. M G Srinivas (Edited by), "Remote sensing applications", Narosa Publishing House, 2001.
6. Burrough P A., "Principles of GIS for land resource assessment", Clarendon Press, 1994.
7. Michael N. Demers, "Fundamentals of geographic information system", Wiley student edition, 2012.

15CVL457 SURFACE HYDROLOGY AND WATER POWER 2 1 0 3

Unit 1

Introduction: Hydrologic cycle - systems concept - hydrologic system model - hydrologic model classification. Stream flow measurement - measurement of stage – discharge measurements. Stage – discharge relations - selection of a stream gauging site – stream gauge network.

Evaporation – measurement, estimation and control of evapo-transporation (ET) – estimation of evapo-transpiration – evapo-transpiration and consumptiveuse – measurement of ET – lysimeters and field pots – potential ET and its computation – pan evaporation - Pennman's method – Blaney Criddle method – reference crop ET and crop coefficient – interception and depression storage.

Infiltration processes – measurement using infiltrometers – infiltration capacity – infiltration indices – Hortan's model of infiltration.

Rain water harvesting – manmade alterations in hydrologic cycle – methods of water conservation.

Unit 2

Runoff - components of runoff - Characteristics of runoff – factors affecting runoff – components of hydrograph – base flow separation – rain fall – runoff relations – flow duration curve - flow mass curve - hydrograph analysis - unit hydrograph theory – derivation of unithydrograph – applications and limitations of unit hydrograph – 'S' hydrograph – instantaneous unit hydrograph – unit hydrograph for ungauged catchments – synthetic hydrograph – conceptual elements – linear reservoirs – Nash model. Yield from a catchment – flow duration curves – flow mass curve.

Floods – estimation of peak discharge – rational method - unit hydrograph method. Probabilistic and statistical methods – basic concept of probability and frequency distribution – skewness coefficient – return period discrete distribution – Binomial distribution – continuous distribution – flood frequency analysis – normal, lognormal, Gumbel and Log-Pearson Type III methods. Flood routing – reservoir routing – Modified pulse method – channel routing – Musking hum method.

Unit 3

Planning for water power development – estimation of available water power-power duration curve - storage and pondage - load studies - load duration curve - variations in load factor - power system load - system integrated operational studies - load prediction - market requirements of power - installed capacity - Benefits evaluation of installed capacity.

Classification of hydropower development - storage power development - runoff river power development - pumped storage power development - small hydro power development.

Hydro power plants - power plant structure - layout of hydropower plants - types of power houses - sizing of power house.

Water conductor system – intakes - location and types of intakes - penstock and pressure shafts - water hammer - water hammer equation - types of surge tanks.

TEXTBOOKS:

1. K. Subramanya, "Engineering Hydrology", Tata McGraw - Hill publishers, New Delhi, 2008.
2. Duggel K. N., and J. P. Soni, "Elements of Water resources engineering", New Age International Publishers, 2005.

REFERENCES:

1. Raghunath H. M., "Hydrology: Principles, Analysis& Design", New Age International, 2015.
2. P. N. Modi, "Irrigation, Water Resources, and Water power Engineering", Standard Book House, 2014.

15CVL458 WATER RESOURCES SYSTEM PLANNING AND DESIGN 2 1 0 3

Unit 1

Water systems engineering – scope and approach. Issues and the systems planning approach - water system dynamics - water resource development alternatives – Water systems planning objectives - Constraints and Criteria – Economic and Econometric principles.

Hydrologic input analysis, Demand analysis, System elements & Subsystem planning - Stochastic planning and management - Design and management issues.

Unit 2

Optimization methods and their application in water resource systems. Linear programming and Dynamic programming models. Problem formulation for W. R systems – Multi-objective planning – Large scale system analysis - Case studies.

Unit 3

Ground water system planning – Conjunctive surface and G. W development - Hierarchical approach - Water quality management planning - Regional planning - Policy issues.

REFERENCE BOOKS:

1. *S K Jain and V P Singh, "Water Resources Systems Planning and Management", Elsevier Science, 2003*
2. *Maass. A. et.al., "Design of Water Resources Systems", Harvard University Press 2013.*
3. *M. C. Chathurvedi, "Water Resources Systems: Planning & Management", Tata McGraw Hill Publications, 1987.*
4. *Louks D P et.al, "Water Resources System Planning & Analysis", Prentice Hall, 1981.*
5. *Goodman. A. S. and Major D. C.,"Principles of Water Resources Planning", Prentice Hall, 1984.*

15CVL460 ADVANCED ENVIRONMENTAL ENGINEERING 2 1 0 3

Unit 1

Instrumental methods for analysis of contaminants in air, water and soil - colorimetry,

Chromatography, spectroscopy, electrochemical probes

Indoor and outdoor air pollution – meteorology - influence of solar radiation and wind fields - lapse rate and stability conditions - characteristics of stack plumes - effective stack height.

Characteristics and health effects of various air pollutant particulates (PM2.5, PM10) and gaseous pollutants (CO, NOx, SOx, etc) - their behaviour in atmosphere – monitoring.

Photochemical reactions - secondary pollutants.

Control devices for Particulate and Gaseous pollutants – applications.

Unit 2

Advances in waste water treatment – Aerobic Suspended growth Process - Process for biological nitrogen removal – design criteria – anoxic, aerobic process design – sequencing batch reactor (SBR) – process analysis - Process for biological phosphorus removal – design criteria.

Aerobic attached growth Process – Rotating biological contactor, Activated Biofilter – Fluidized bed bioreactor (FBBR) design criteria.

Anaerobic suspended and attached growth process - Up flow anaerobic sludge blanket reactor.

Unit 3

Tertiary treatment – disinfection of waste water - waste water recycling – Water reuse. Advances treatment units – Removal of organic and inorganic colloidal and suspended solids – Removal of dissolved organic constituents – Removal of dissolved inorganic constituents – Filtration – Membrane filtration – Adsorption - Distillation processes.

TEXTBOOK:

Metcalf and Eddy, "Waste Water Engineering Treatment Disposal Reuse", Tata McGraw Hill, 2002.

REFERENCE BOOKS:

1. *Clarence, J. Velz, "Applied Stream Sanitation", Krieger Pub Co., 1984.*
2. *C. S Rao, "Environmental Pollution Control Engineering", New Age Publications, 2006.*
3. *Nevers, Noel De, "Air Pollution Control Engineering", McGraw-Hill, 1999.*

15CVL461 ENVIRONMENTAL IMPACT ASSESSMENT 2 1 0 3

Unit 1

Concept of environment, Concept of environmental impact, Environmental impact assessment (EIA) – definitions, terminology and overview, Evolution of EIA in the USA, Key features of the National Environmental Policy Act and its implementation and the Council on Environmental Quality (CEQ) guidelines, Role of the USEPA, Evolution of EIA in India, Sustainable development, Generalised EIA process flow chart, Screening, Initial environmental examination (IEE), Scoping, Public participation.

Unit 2

Environmental baseline, Impact assessment methods – checklists – matrices - quantitative methods – networks - overlay mapping. Introduction to impact prediction and evaluation, Factors to be considered while assessing the impacts of water related projects, power projects, waste water treatment facilities etc. Major features of the EIA notification in India, Present status and procedures of EIA in India.

Unit 3

Prediction and assessment of impacts of developmental activities on surface water, land and soil, groundwater, air, biological environment etc.

Prediction and assessment of visual impacts, Socioeconomic impact analysis, Evaluation of alternatives, Preparingthe EIA document, Environmental impact statement (EIS), Environmental monitoring, Environmental audit (EA).Case studies.

REFERENCE BOOKS:

1. *Larry W Canter, Environmental Impact Assessment, McGraw Hill, Inc, 1995.*
2. *Betty Bowers Marriot, Environmental Impact Assessment: A Practical Guide, McGraw Hill, Inc, 1997.*
3. *Barrow, C. J., Environmental and Social Impact Assessment – An Introduction, Edward Arnold, 1997.*
4. *Evan. K. Paleologos and Ian Lerche, Environmental Risk Analysis, McGraw Hill Inc, 2001.*
5. *Peter Morris (ed.) and Riki Therivel (ed.), Methods of Environmental Impact Assessment, Routledge, 2001.*
6. *UNEP, Environmental Impact Assessment Training Resource Manual, 2002.*
7. *Website of the Ministry of Environment and Forests, Govt. of India and the USEPA.*

15CVL462 INDUSTRIAL WASTE TREATMENT 2 1 0 3

Unit 1

Nature and characteristics of Industrial wastes - prevention versus control of industrial pollution - Linkage between technology and pollution prevention - tools for clean processes - reuse, recycle, recovery, source reduction, raw material substitution, toxic use reduction and process modification - separation technologies as tools for waste minimization - Flow sheet analysis - Energy and resource audits - waste audits.

Unit 2

Preliminary treatment of industrial waste water – volume reduction – strength reduction – neutralization – equalization and proportioning.

Treatment of industrial waste - suitability of different techniques - disposal of industrial waste.

Unit 3

Effluent generation from textile industry – paper industry – dairy – fertilizer – thermal power plants - effluent characteristics - treatment.

Membrane process, ion exchange process, Reverse osmosis, Ultra filtration, electrolysis.

Study of damages caused by industrial pollution in India.

REFERENCE BOOKS:

1. *Nelson Leonard Nemerow, "Industrial waste treatment – contemporary practice and vision for the future", Elsevier, Singapore, 2007*
2. *Gerard Kiely, "Environmental Engineering", McGraw Hill, 2009.*

3. *Sincero A. P. and Sincero G. A., "Environmental Engineering - A Design Approach", Prentice Hall, 1996.*
4. *Mahajan S. P., "Pollution Control in Process Industries", Tata McGraw Hill, 2001.*
5. *Babbitt H. E, "Sewerage & Sewage Treatment", Nabu Press, 2010.*
6. *Abbasi S. A, and Ramasami E, "Biotechnical Methods of Pollution Control", Universities Press(India) Ltd., 1999.*

15CVL470 PAVEMENT DESIGN 2 1 0 3

Unit 1

Introduction: Types and component parts of pavements – factors affecting design and performance of pavements - comparison between highway and airport pavements - functions and significance of sub grade properties – various methods of assessment of sub grade soil strength for pavement design - cause and effects of variations in moisture content and temperature - depth of frost penetration - design of bituminous mixes by Marshall method.

Unit 2

Stress analyses and methods of flexible pavement design: stresses and deflections in homogeneous masses - burmister 2 layer and 3 layer theories - wheel load stresses - ESWL of multiple wheels - repeated loads and EWL factors - empirical, semi-empirical and theoretical approaches for flexible pavement design - group index, CBR, triaxial, mcleod and burmister layered system methods.

Unit 3

Stresses analysis and methods of rigid pavement design: types of stresses and causes - factors influencing stresses, general conditions in rigid pavement analysis – ESWL - wheel load stresses - warping stresses – friction stresses - combined stresses - functions of various types of joints in cement concrete pavements - design and detailing of slab thickness; longitudinal, contraction and expansion joints by IRC recommendations.

Pavement evaluation and rehabilitation.

TEXTBOOK:

Khanna S. K. and Justo, C E G, "Highway Engineering", Nem Chand and Bros, 2011.

REFERENCE BOOKS:

1. *Yoder and W Nitezak, "Principles of Pavement Design", John Wiley, 1975.*
2. *Yang. H. H., "Pavement Analysis and Design", Pearson Education, 2010.*
3. *IRC: 37 - 2001, "Guidelines for the Design of Flexible Pavements"*
4. *IRC: 58 - 2002, "Guidelines for the Design of Rigid Pavements"*
5. *David Croney, "The Design and Performance of Road pavements", McGraw Hill, 1997.*

6. *Haas R., Hudson W. R., and Zaniewski, J., "Pavement Management System", McGraw Hill Book Co, 1994.*
7. *IRC 81-1981- "Tentative Guidelines for Strengthening of Flexible Pavements by Benklman Beam Deflections Techniques".*

15CVL471 TRAFFIC ENGINEERING AND MANAGEMENT 2 1 0 3

Unit 1

Introduction - Objectives and scope of traffic engineering - Components of road traffic: vehicle, driver and road - Road user and vehicle characteristics and their effect on road traffic - Traffic manoeuvre - Traffic Stream Characteristics - Relationship between Speed, Flow and Density.

Objectives, methods, equipment, data collection, analysis and interpretation (including case studies) of (a) Speed and delay, (b) Origin and destination, (c) Parking, (d) Accident and other studies.

Unit 2

Design, Regulation and Management of Traffic Engineering Facilities: Control of traffic movements through time sharing and space sharing concepts - Design of channelising islands, T, Y, skewed, staggered, roundabout, mini-roundabout and other forms of at-grade crossings including provision for safe crossing of pedestrians and cyclists - Grade separated intersections: Warrants and design features - Bus stop location and bus bay design - Road lighting - Regulations on vehicles, drivers and traffic - Planning and design of traffic management measures: one-way streets, reversible lanes and roadways, turn regulation, transit and carpool lanes - Planning and design of pedestrian facilities – Traffic calming.

Unit 3

Traffic Control Devices and Environmental Control: Different methods of signal design - Redesign of existing signals including case studies - Signal coordination - Air and Noise pollution of different transport modes – Visual impacts - Impacts on land development -Technological approaches to improving environment.

TEXTBOOKS:

1. *Elena S. Prassas, Roger P. Roess, William R. McShane, "Traffic Engineering", Pearson, 2010.*
2. *Kadiyali, L. R., "Traffic Engineering and Transport Planning", Khanna Publishers, 2007.*

REFERENCE BOOKS:

1. *O' Flaherty C. A., "Traffic Planning and Engineering", Elsevier India, 2006.*
2. *Fred L. Mannering, Scott S. Washburn, and Walter P. Kilareski, "Principles of Highway Engineering and Traffic Analysis", Wiley, 2011.*
3. *Pignataro, L., "Traffic Engineering - Theory and Practice", Prentice Hall, 1973.*

4. *Institute of Transportation Engineers, "Transportation and Traffic Engg. Hand Book", 6th edition, 2009.*
5. *IRC-SP41, Guidelines for the Design of At-Grade Intersections in Rural and Urban Areas, 1994.*
6. *Leonard Evans, "Traffic Safety", Science Serving Society, 2004.*
7. *Michael, A. P. Taylor, William Young, and Peter W. Bonsall, "Understanding Traffic Systems", Ashgate Publishing, 2000.*
8. *Mike Slinn, Paul Matthews, Peter Guest, "Traffic Engineering Design - Principles and Practice", Butterworth-Heinemann, 2005.*

15CVL472 TRANSPORTATION SYSTEM MANAGEMENT AND CONTROL 2 1 0 3

Unit 1

Traffic Engineering Facilities and Control: Control of Traffic Movements through Time Sharing and Space Sharing Concepts – Design of Channelising Islands - T, Y, Skewed, Staggered, Roundabout, Mini-Round about and other At-Grade Crossings and Provision for Safe Crossing of Pedestrians and Cyclists; Grade Separated Intersections, their warrants and Design Features, Bus Stop Location and Bus Bay Design.

Traffic Control Devices: Traffic Signs and Signals, Principle of Signal Design, Webster's Method, Redesign of Existing Signals including Case Studies; Signal System Coordination.

Unit 2

TSM Actions:

Combination and Interactions, Input Assessment and Evaluation, Monitoring and Surveillance, Study of following TSM Actions with respect to:

1) Problems Addressed 2) Conditions for Applications 3) Implementation Problems 4) Evaluation and Impact Analysis.

Public Transportation and HOV Treatment, Toll discounts for Car Pools during Peak periods, Park and Ride, Car pooling, Exclusive Bus & Two-wheeler Lanes, Priority at Ramp Terminals, Bus Transfer Stations, Limited Skip & Stop Bus Services & Shared Rides.

Unit 3

Demand Management: Staggered Working hours, Flexible Work hours, High Peak Period Tolls, Shuttle Services, Circulation Services and Extended Routes.

Traffic Operations Improvements: On-Street, Parking ban, Freeway Ramp Control and Closure, Travel on Shoulders, One-way Streets, Reversible Lanes, Traffic Calming, Right Turn Phase, Right Turn Lanes, Reroute Turning Traffic.

TEXTBOOK:

Kadiyali, L. R., "Traffic Engineering and Transport Planning", Khanna Publishers, 2007.

REFERENCE BOOKS:

1. *Institute of Transportation Engineers, "Transportation and Traffic Engineering Hand Book", 6th edition, 2009.*
2. *Salter, R. J., "Highway Traffic Analysis and Design", Palgrave Macmillan, 1996.*
3. *Louis J. Pignataro, Edmund J. Cantilli, "Traffic Engineering – Theory and Practice", Prentice Hall, 1973.*
4. *IRC- SP41-1994: Guidelines for the Design of At-Grade Intersections in Rural and Urban Areas.*

15CVL473 URBAN TRANSPORTATION PLANNING 2 1 0 3

Unit 1

Urban Transportation Planning Process & Concepts: Role of transportation - Transportation problems - Urban travel characteristics - Evolution of transportation planning process - Concept of travel demand - Demand function - Independent variables - Travel attributes - Assumptions in demand estimation - Sequential, recursive and simultaneous processes.

Unit 2

Transportation Survey and Analysis: Definition of study area - Zoning - Types and sources of data - Road side interviews - Home interview surveys - Expansion factors - Accuracy checks.

Trip Generation Analysis: Trip generation models - Zonal models - Category analysis - Household models - Trip attractions of work centers.
Trip Distribution Analysis: Trip distribution models - Growth factor models - Gravity models - Opportunity models.

Unit 3

Mode Split Analysis: Mode choice behaviour, Completing modes, Mode split curves, Probabilistic models.

Route Split Analysis - Elements of transportation networks, coding - minimum path trees, all-or-nothing assignment.

TEXTBOOK:

Hutchinson B. G., "Principles of Urban Transportation System Planning", McGraw Hill, 1974.

REFERENCE BOOKS:

1. *Khanna S. K and Justo. C. E. G., "Highway Engineering", Nem Chand &Bros., 2011*
2. *Kadiyali L. R., "Traffic Engineering and Transportation Planning", Khanna Publishers, 2008.*
3. *Khisty C. J. and lall. B. K., "Transportation Engineering - An Introduction", Prentice Hall, 2002.*
4. *Bruton M. J., "Introduction to Transportation Planning", Hutchinson of London, 1992.*

5. *Papacostas, C S, and Prevedouros. P. D, "Transportation Engineering and Planning", Prentice Hall, 2009.*
6. *Dicky J. W., "Metropolitan Transportation Planning", Taylor & Francis, 1983.*

15CVL481 STRUCTURAL DESIGN AND DETAILING 0 0 2 1

Design drawing and detailing of RC elements / structures – preparation of detailed design documents, schedules of structural elements and reinforcement details (structural drawing).

- Framed structure
- Retaining walls
- Water tanks

Design and detailing of steel elements / structures

- Built-up columns and Column bases
- Roof trusses and joints including purlins
- Gantry girder

Computer aided analysis and design

- Multi-storey frame analysis for dead, live and wind loads - Applications.
- Design of Reinforced concrete Beams, Columns – Footings – Steel beams – columns - Trusses

TEXTBOOKS:

1. *N. Krishna Raju, "Structural Design and Drawing – Reinforced Concrete and Steel", Universities Press, 2005.*
2. *M. L. Gambhir, "Design of Reinforced Concrete Structures", PHI Learning, 2009.*

REFERENCE BOOKS:

1. *D. Krishnamoorthy, "Structural Design & Drawing Vol. I&II", CBS Publishers, 2012.*
2. *Karve, Shah,"Illustrated Design of R. C. Buildings (G+3)", Standard Publishers Distributors, 2008.*
3. *SP:34-1987, "Handbook on Concrete Reinforcement and Detailing", BIS.*

15CVL491 PROFESSIONAL PROJECT 0 1 2 2

The objective of this course is to impart and improve the design capability of the student. This course conceives purely a design problem in any one of the disciplines of Civil Engineering; e.g., Design of a RC structure, Design of a waste water treatment plant, Design of a foundation system, Design of traffic intersection etc. The design problem can be allotted to a group of students comprising of not more than four. At the end of the course the group should submit a complete report on the design problem consisting of the data given, the design calculations, specifications if any and complete set of drawings which follow the design.

15CVL495 PROJECT PHASE I 2 cr

The student is expected to start the initial planning and preparation for the final year project. They have to identify their team, project advisor and, plan the objectives, scope, methodology and the work schedule. A detailed literature review is also expected in this phase.

15CVL499 PROJECT PHASE II 10 cr

The student is expected to work on a topic in the field of Civil Engineering which could involve theoretical and/or fabrication and/or experimental and/or computational work. Evaluation will be done at the mid-course, as well as at the end of the semester.

15ECE111 SOLID STATE DEVICES 3 0 0 3

Unit 1

Introduction to Semiconductor materials, Crystal Structure of Silicon and GaAs – Planes – directions - planes and planar atomic densities - Unit cell characteristics - Review of Quantum Mechanics – Dual Nature of Light and Electrons - Bohr model of atom, Uncertainty Principle - Time dependent and Time independent Schrodinger Wave equation - Infinite Potential well problem - Step Potential Function - Tunneling.

Unit 2

Molecular Orbital theory and formation of energy bands in semiconductors - Direct and Indirect band gap semiconductors - Charge carriers - Effective mass - Extrinsic and intrinsic semiconductors - Fermi Dirac Statistics and Fermi Level - Boltzman Statistics - Density of states - Equilibrium Carrier concentrations - Drift velocity and mobility - Temperature dependence of carrier concentration – mobility - and conductivity - Hall effect - Excess Carriers and photoconductivity - Diffusion of Carriers - Built in fields.

Unit 3

Direct and indirect recombination - excess carrier lifetime - Steady State Carrier generation - Quasi Fermi levels - Continuity Equation - Haynes Shockley experiment - Equilibrium PN junctions - Band diagram - built in potential and electric field in space charge region - depletion width - Forward and Reverse Biased PN junction - Ideal Diode equation - Reverse bias breakdown - PN Junction diodes - MOSFET Physics - Threshold voltage - Fundamentals of BJT physics.

TEXTBOOKS:

1. *Ben G. Streetman and Sanjay Kumar Banerjee, "Solid State Electronic Devices", Prentice Hall India, Sixth Edition, 2009.*

2. *Donald A. Neamen, "Semiconductor Physics and Devices: Basic Principles", McGraw-Hill International, Third Edition, 2003.*

REFERENCES:

1. *S. M. Sze and Kwok K. NG, "Physics of Semiconductor Devices", John Wiley and Sons, Inc., Third Edition, 2007.*
2. *S. O. Kasap, "Principles of Electronic Materials and Devices", Tata McGraw Hill, Third Edition, 2007.*

15ECE112 FUNDAMENTALS OF ELECTRICAL TECHNOLOGY 3 1 0 4

Unit 1

Introduction to Electrical Power System - Ideal Independent Current and Voltage Sources - Reference Directions and Symbols – Resistance - Inductance - Capacitance - Ohm's law, Kirchhoff's law - Energy and Power - Series parallel combination of R,L and C Components - DC Series - Parallel Circuits - Voltage Divider and Current Divider Rules - Superposition Theorem - Network Analysis - Mesh and Node methods - Generation of sinusoidal voltage – Instantaneous - Average and effective values of periodic functions - Phasor representation.

Unit 2

Reactance and Impedance - Response in RLC circuits to sinusoidal voltage - Real and Reactive Power - Power factor - Complex Power and Power Triangle: Introduction to Three Phase Systems - Balanced 3-Phase STAR and DELTA connections of Load - Three phase power.

Unit 3

Measuring Instruments for AC and DC quantities: Instruments to measure Voltage – Current - Power and Energy - Electromagnetic Induction - Magnetic Circuit Elements - Self and Mutual Inductances - Classification and Applications of Electrical Machines – Torque - Output Power and Efficiency. 3-Phase Induction Motor: Principle of operation – Slip – Torque - Speed relation. Single Phase and Three Phase Transformers - Principle of Operation - Turns ratio and connections.

TEXTBOOKS:

1. *Edward Hughes, "Electrical Technology", Pearson Education Asia, Seventh Edition 2011.*
2. *A. P. Malvino, "Electronic Principles", Tata McGraw Hill, Seventh Edition, 2007.*

REFERENCES:

1. *S K Bhattcharya, "Basic Electrical and Electronics Engineering", Pearson, 2012.*
2. *Vincent Del Toro, "ElectricalEngineering Fundamentals", Prentice Hall of India Private Limited, Second Edition, 2003.*
3. *David A Bell, "Electronic Devices and Circuits", Oxford University Press, Fifth Edition, 2008*
4. *Michael Tooley B A, "Electronic Circuits: Fundamentals and Applications", Elsevier Ltd, Third Edition, 2006.*

15ECE201 APPLIED ELECTROMAGNETICS 3 1 0 4

Unit 1

Static Electric Fields: Co-ordinate systems – Review - Line integral - Surface integral – Gradient – Divergence - Curl-Stoke's theorem - Divergence theorem - Helmholtz theorem - Electrostatics - Postulates - Coulomb's law - Gauss law - Electric potential - Behaviour of conductors and dielectric in static fields - Dielectric constant - Poisson's and Laplace equation.

Unit 2

Steady currents and magnetic fields: Current density - Point form of Ohm's law – Continuity equation - Lorentz force - Magneto statics – Postulates - Magnetic vector potential – Biot-Savart law - Relative permeability - Hall effect.

Unit 3

Electromagnetic Fields: Faraday's law of Induction - Maxwell's equations - Differential and Integral Forms - Boundary Conditions for electromagnetic fields - Wave equation - Time harmonic electromagnetic fields.

TEXTBOOK:

David K. Cheng, "Field and Wave Electromagnetics", Pearson Education, Second Edition, 2002.

REFERENCES:

1. *Clayton R. Paul, Keith W. Whites, Syed A. Nasar, "Introduction to Electromagnetic Fields", Tata McGraw-Hill Education Private Limited, Third Edition (Fifth Reprint), 2009.*
2. *Kraus, Fleisch, "Electromagnetics with Applications", Tata McGraw Hill Education Private Limited, Fifth Edition, 2004.*

15ECE202 DIGITAL CIRCUITS AND SYSTEMS 3 1 0 4

Unit 1

Introduction to logic families: ECL – TTL - Tri state logic. Implementation technology: Transistor switches - NMOS logic gates - CMOS logic gates - Negative logic systems. Introduction to logic circuits: Variables and functions, inversion - Truth tables - Logic gates and Networks - Boolean algebra - Synthesis using gates - Design examples - Optimized implementation of logic functions: Karnaugh map - Strategy for minimization - Minimization of product of sums forms - Incompletely specified functions - Multiple output circuits - Tabular method for minimization - Number representation and arithmetic circuits: Addition of unsigned numbers - Signed numbers - Fast adders.

Unit 2

Combinational circuit building blocks: Multiplexers - Decoders - Encoders - Code converters - Arithmetic comparison circuits. Sequential circuit building blocks: Basic

latch - Gated SR latch - Gated D latch - Master slave and edge triggered - D flip-flops - T flip-flop - JK flip-flop - Registers - Counters - Reset synchronization - Other types of counters.

Unit 3

Synchronous sequential circuits: Basic design steps - State assignment problem - Mealy state model - Serial adders - State minimization. Asynchronous sequential circuits:Analysis of asynchronous circuits.

TEXTBOOK:

Stephen Brown, ZvonkoVranesic, "Fundamentals of Digital logic with Verilog Design", Tata McGraw Hill Publishing Company Limited, Special Indian Edition, 2007.

REFERENCES:

1. *Morris Mano, Michael D. Ciletti "Digital Design – with introduction to Verilog HDL", Pearson Education, Fifth Edition, 2011.*
2. *Charles H., Jr. Roth, LizyKurian John, Beyond Kill Lee, "Digital System Design Using Verilog", Cengage Learning, 2015.*
3. *Donald D Givone, "Digital Principles and Design", Tata McGraw Hill Publishing Company Limited, 2003.*

15ECE203 NETWORK THEORY 3 0 0 3

Unit 1

Practice of Mesh Current and Node Voltage analysis of circuits with independent and dependent sources.

Network Reduction: Source transformation - Star-Delta transformation. Network Theorems: Thevenin and Norton'stheorems - Superposition theorem - maximum power transfertheorem - Tellegan'stheorem, Reciprocitytheorem. Introduction to Graph Theory – Definitions - Incidence matrix - Fundamental tie-set matrix - Fundamental cutest matrix - Formulation of network equations using KCL and KVL.

Unit 2

Transient Analysis: Time domain analysis of first and second order circuits - with DC Excitation - Frequency response of Series and Parallel circuits - Resonance - Q-factor and Bandwidth. Steady State Analysis of single phase AC circuits: Phasor representation and analysis of circuits applying network theorem; Power factor – power factor correction. Self and mutual Inductance - Coupled circuits – dot convention.

Unit 3

Two-port Networks and Filters – Voltage and Current ratios of two port networks – Admittance – impedance- hybrid and transmission parameters of two port

networks. Passive filters as two port networks - Transient response and reduction of overshoot, sensitivity. Active filters: poles and zeros, filter design. Attenuators: Image and scattering parameters, insertion loss. Various types of attenuators.

TEXTBOOKS:

1. *Charles K Alexander, Mathew N. O. Sadiku, "Fundamentals of Electric circuits", Tata McGraw-Hill, 2003.*
2. *John D. Ryder, Myril Baird Reed and W. L. Everitt, "Foundation for Electric Network Theory", Prentice Hall of India, Second Edition, 2013.*

REFERENCES:

1. *M. E. Van Valkenburg, "Network Analysis", Prentice Hall India Private Limited, Third Edition, 1999.*
2. *K. V. V. Murthy, M. S. Kamath, "Basic Circuit Analysis", Tata McGraw Hill Publishing Company Limited, 2006.*
3. *D. Roy Chaudhary, "Networks and Systems", New Age International Publisher, 2003*
4. *N. Balabanian, T. Bickart, "Linear Network Theory: Analysis, Properties, Design and Synthesis", Matrix Publishers Inc., 1981.*

15ECE204 SIGNAL PROCESSING I 3 1 0 4

Unit 1

Introduction: Integrated approach for continuous, discrete-time cases.

Signals: Classification of signals, continuous – discrete time; even / odd signals, periodic / nonperiodic signals, deterministic / random signals, energy / power signals: Basic operations on signals: Basic (continuous / discrete) signals – unit step, unit impulse, sinusoidal and complex exponential signals etc. Systems (continuous / discrete): Representation, classification – linear / nonlinear, causal / noncausal, time invariant / time variant, with / without memory - BIBO stability, feedback systems. LTI system response of LTI system - convolution, properties (continuous / discrete) - LTI systems – differential / difference equation representation.

Unit 2

Fourier Series: Fourier series - Half range Expansions - Parseval's Identity - Transform integrals¬ - Fourier Integrals - Fourier integral theorem. Sine and Cosine Integrals. Fourier analysis of continuous time signals and systems: Fourier series for periodic signals - Sine and Cosine Transforms - Fourier transform – properties of continuous time FT - Sampling: Sampling theorem - reconstruction of signal – aliasing.

Unit 3

Laplace Transform analysis of systems: Laplace Transforms, Inverse Transforms, Linearity, Shifting, Transforms of Derivatives and Integrals – ROC - inverse LT -

unilateral LT - Frequency response of continuous time LTI systems, response of electronic circuits with initial conditions using Lapalce transforms. Z-Transform: Definition – ROC - inverse z-transform – properties - transform analysis of LTI Systems - Frequency response of discrete time LTI systems. Inter relationship between different representations and transforms.

TEXTBOOKS:

1. *Alan V. Oppenheim, Alan S. Wilsky, S, Hamid Nawab, "Signals and Systems". Prentice Hall India private Limited, Second Edition, 1997.*
2. *E Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, Ninth Edition, 2012.*

REFERENCES:

1. *Simon Haykin, Barry Van Veen, "Signals and Systems", Second Edition, John Wiley and Sons, 2005.*
2. *Lathi B P, " Signal Processing & Linear Systems", Oxford University Press, 2006*
3. *Michael J. Roberts, "Fundamentals of Signals and systems", Tata McGraw Hill Publishing Company Limited, First Edition, 2007.*
4. *Rodger E. Ziemer, William H. Tranter D. Ronal Fannin, "Signals and Systems", Pearson Education, Fourth Edition, 2004.*

15ECE211 ELECTRONIC CIRCUITS 3 1 0 4

(Pre-requisite: 15ECE111 Solid State Devices)

Unit 1

Diode Fundamentals: Diode characteristics - Physics of diode operation and modeling of diodes.

Diode applications: Rectifiers - Clipper and clamper circuits - Voltage multipliers - Voltage regulator using zener diode.

Unit 2

Bipolar junction transistors: Introduction - Operation of BJT–I-V characteristics of BJT. BJT Applications: BJT biasing techniques - Analysis of BJT as a switch and as an amplifier - Small signal analysis - Single stage BJT amplifiers (CE, CB, CC) - BJT high frequency models and amplifier frequency analysis.\

Unit 3

Field effect transistors: Introduction - Device structure and operation of JFET (Junction Field Effect Transistor) and MOSFETs - I-V characteristics of JFET and MOSFET - MOSFET applications - MOSFET biasing techniques - Analysis of MOS as a switch and as an amplifier - Small signal analysis - Single stage MOS amplifiers (CS, CD, CG) MOS capacitances - MOS high frequency and model and amplifier frequency analysis.

TEXTBOOK:

Sedra A and Smith K C, "Microelectronic circuits", Sixth Edition, Oxford University Press, 2010.

REFERENCES:

1. *Neamen D A, "Electronic circuit analysis and design", McGrawHill, 2001.*
2. *Boylestad R L and Nashelsky L, "Electronic devices and circuit theory", Upper Saddle River N.J., Pearson/Prentice Hall, Tenth Edition, 2009.*

15ECE212 SIGNAL PROCESSING II 3 1 0 4

(Pre-requisite: 15ECE204 Signal Processing I)

Unit 1

Discrete Fourier transforms: Fourier Transform, Fourier analysis of discrete time signals and systems: Discrete time Fourier series – Discrete Time Fourier Transform-properties of DTFT – Introduction to DFT - properties of DFT – linear filtering methods based on DFT – FFT– efficient computation of the DFT of a 2N- point real sequences – correlation – use of FFT in linear filtering and correlation.

Unit 2

Digital filters: Introduction, specifications of practical filters, Characteristics of commonly used analog filters – IIR filters: design by approximation of derivatives – impulse invariance and Bilinear transformation – frequency transformations for analog and digital filters.

FIR filters: symmetric and anti-symmetric FIR filters – design of linear phase FIR filter using Windows – FIR differentiators – Hilbert transforms – comparison of design methods for linear phase FIR filters.

Unit 3

Digital filters realizations: Structures for IIR systems – direct form structures, cascade form structures, parallel form structures, Structures for FIR systems – direct form structures, Linear phase and cascade form structures.

Applications of DSP - a few case studies.

TEXTBOOK:

John G Proakis, G. Manolakis, "Digital Signal Processing Principles, Algorithms, Applications", Prentice Hall India Private Limited, Fourth Edition, 2007.

REFERENCES:

1. *Sanjit K. Mitra, "Digital Signal Processing. A Practical approach", Tata McGraw Hill Publishing Company Limited, 2005.*
2. *Allen V. Oppenheim, Ronald W. Schafer, "Discrete time Signal Processing", Prentice Hall India Private Limited, Fifth Edition, 2000.*

15ECE213 TRANSMISSION LINES AND WAVEGUIDES 3 0 0 3

(Pre-requisite: 15ECE201 Applied Electromagnetics)

Unit 1

Plane Wave Theory: Plane waves in lossless and lossy media – Types of media – Skin effect – Poynting vector and group velocity – Normal incidence at conducting and dielectric boundary – Brief review of oblique incidence.

Unit 2

Transmission line theory: TEM wave along parallel plate line – Transmission line parameters – General equations – Infinite line concept – Transmission line parameters – Finite line properties – Input impedance – Smith chart calculations – Transmission line impedance matching techniques – Stub matching.

Unit 3

Wave Guiding Systems: Transverse Electric (TE) and Transverse Magnetic(TM) modes – Electromagnetic waves between parallel plates (TE and TM) – Properties – Rectangular waveguides – TE and TM waves in rectangular waveguides – Properties - Attenuation in waveguides.

TEXTBOOK:

1. *David K.Cheng, "Field and Wave Electromagnetics", Pearson Education, Second Edition, 2002.*

REFERENCES:

1. *Clayton R. Paul, Keith W. Whites, Syed A. Nasar, "Introduction to Electromagnetic Fields", Tata McGraw-Hill Education Private Limited, Third Edition (Fifth Reprint), 2009.*
2. *John Daniel Kraus , Daniel A. Fleisch, "Electromagnetics with Applications", Tata McGraw Hill Education Private Limited, Fifth Edition, 2004.*

15ECE281 DIGITAL CIRCUITS AND SYSTEMS LAB. 0 0 2 1

1. Familiarization of Digital trainer kit and study of logic gates.
2. Realization of Boolean expressions using logic gates
3. Realization of Boolean expressions using universal gates
4. Realization of code converters
5. Design of Adders/Subtractors
6. Design of Multiplexers/ De-Multiplexers
7. Design of Encoders/ Decoders
8. Study of flip-flops
9. Design of Synchronous counters
10. Design of Asynchronous counters

15ECE282 SIGNAL PROCESSING I LAB. 0 0 2 1

1. Introduction to Matlab
2. Generation of sequences
3. Basic operations on signals
4. Properties of system
5. Convolution
6. Interconnection of systems
7. Frequency response of LTI Systems
8. Frequency domain representation
9. Time shifting property - DTFS
10. LTI System - analysis

15ECE285 DIGITAL SIGNAL PROCESSING LAB. 0 0 2 1

1. Generation of signals
2. Sampling of analog signals and study of aliasing
3. Computation of DFT using direct / linear transformation method
4. Properties of DFT
5. Computation of 2-N point DFT of a real sequence by using an N point DFT just once.
6. Linear filtering using Overlap add /save method
7. Design of FIR filter (different windowing technique)
8. Design of IIR Butterworth filter
9. Applications of DSP - a few case studies

15ECE286 ELECTRONIC CIRCUITS LAB. 0 0 2 1

1. P-N junction Diode and Zener Diode Characterization.
2. Rectifier with and without filters
3. Clippers/ Clampers
4. Shunt regulator
5. BJT Characterization
6. Single stage CE amplifier

15ECE301 COMMUNICATION THEORY 3 1 0 4

Unit 1

Introduction to analog communication system - Amplitude Modulation (AM) - Double Sideband Suppressed Carrier (DSB-SC) - Single Sideband (SSB) - Quadrature AM (QAM) - Vestigial Sideband (VSB) – Generation and demodulation of AM signals.

Unit 2

Frequency Modulation (FM) - Phase Modulation (PM) - Bandwidth of FM signals - Generation and demodulation of FM signals - Frequency Division Multiplexing (FDM) - Superhetrodyne receiver.

Unit 3

Complex low pass representation of narrow band signals - Introduction to random processes - Characterization of noise - Noise analysis of analog modulation systems - Sampling theorem - Time division multiplexing.

TEXTBOOK:

Simon Haykin, "An Introduction to Analog and Digital Communications", Wiley, Second Edition, 2006,

REFERENCES:

1. *J. Proakis, M. Salehi, "Fundamentals of Communications systems", Pearson Education, Second Edition, 2005.*
2. *Herbert Taub, Donald Schilling, "Principles of Communications", Tata McGraw-Hill, 2008.*
3. *Bruce Carlson, "Communication Systems", McGraw-Hill, Fifth Edition, 2010.*

15ECE302 CONTROL SYSTEMS ENGINEERING 3 1 0 4

(Pre-requisite: 15CSE204 Signal Processing I)

Unit 1

Introduction - System Configurations - Analysis and design objectives - Design process - Computer-aided design - Laplace transform review - The transfer function: Electrical network Transfer functions - Translational mechanical system transfer functions - Electric circuit analogs – Nonlinearities – Linearization - Transfer function of a DC motor. Poles Zeros and system response - Time response analysis (1st, 2nd order) - System response with additional poles - System response with zeros. Reduction of multiple system - Block reduction techniques - Signal flow graph - Mason's gain formula. Stability: Routh-Hurwitz criterion - Steady-state error for unity feedback systems - Static error constants and system type - Steady-state error specifications.

Unit 2

The root locus, properties of the root locus - Sketching the root locus - Transient response Design via gain adjustment - Frequency response techniques. Asymptotic approximations: Bode plots - Introduction to the Nyquist criterion – Stability - Gain margin and Phase margin via Nyquist diagram and Bode plots relation between closed loop transient and closed loop frequency responses - Relation between closed and open loop frequency responses - Relation between closed loop transient and open loop frequency responses - Steady-state error characteristics from frequency response - Systems with time delay - Obtaining transfer functions.

Unit 3

Design via frequency response - Transient response design via gain adjustment - Lag compensation - Lead compensation - The general state - Space representation - Applying the state-space representation - Converting a transfer function to state-space - Converting from state-space to a transfer function.

TEXTBOOK:

Norman Nise, "Control System Engineering", John Wiley & Sons, Inc., Sixth Edition, 2011.

REFERENCES:

1. *Dorf R. C. and Bishop R. H, "Modern control systems", Addison-Wesley Longman Inc., Eighth Edition, Indian reprint, 1999.*
2. *Katushiko Ogata, "Modern control engineering", Pearson education, Third Edition, 2004.*
3. *Benjamin C.Kuo, "Automatic Control Systems", Prentice Hall India Ltd, Sixth Edition, 2000.*

15ECE303 LINEAR INTEGRATED CIRCUITS 3 0 0 3

(Pre-requisite: 15ECE211 Electronic Circuits)

Unit 1

Amplifier parameters - Multistage amplifiers. Feedback: Introduction to the concept of feedback - positive and negative feedback - Properties of feedback - Feedback topologies - Non-ideal effects.

Unit 2

Differential Amplifier: The MOS differential pair - Common-mode and Differential signals. Small-signal operation - Differential gain and CMRR. Operational amplifiers: Ideal op-amp - parameters and characteristics - Inverting and non-inverting amplifiers.

Unit 3

Op-amp circuits: Difference Amplifiers - Instrumentation amplifiers – Adder – Subtractor – Integrator – Differentiator – Comparators - Schmitt trigger - Peak detector - Sample and hold circuits - Precision rectifiers - Dual-slope ADC – DVM - R-2R type DAC - Multivibrators - Monostable - Astable and Bistable - Oscillators: RC phase shift and Wein-bridge oscillators - 555 Timer.

TEXTBOOK:

Sedra A and Smith K C, "Microelectronic circuits", Oxford University Press, Sixth Edition, 2010.

REFERENCES:

1. *Neamen D A, "Electronic circuit analysis and design", McGraw-Hill, 2001.*
5. *Franco S., "Design with operational amplifiers and analog integrated circuits", New York, McGraw-Hill, Third Edition, 2002.*
6. *Ramakant A. Gayakwad, "Op-amps and linear integrated circuit technology" Prentice Hall, Fourth Edition, 2000.*
7. *Application Notes and Data Sheets of ICs from various manufacturers.*

15ECE304 MICROPROCESSOR AND MICROCONTROLLER 3 1 0 4

(Pre-requisite: 15ECE202 Digital Circuits and Systems)

Unit 1

8085 Microprocessor: Architecture – Functional block diagram - Registers, ALU, Bus Systems - Timing and Control Signals – Machine cycles and timing diagrams, memory interfacing.

Unit 2

ARM Architecture: Acron RISC Machine – Architectural Inheritance – Programmers Model. ARM Assembly Language Programming: Data Processing Instructions – Data Transfer Instructions – Control Flow Instructions. ARM Organization and Implementation: 3-stage Pipeline – 5-stage Pipeline – ARM Instruction Execution – ARM Implemenation – Coprocessor Interface. ARM Instruction Set – Architectural Support for High-Level Programming – Thumb Instruction Set.

Unit 3

Architectural Support for System Development: ARM memory Interface – AMBA Interface – The ARMulator – JTAG Boundary Scan Architecture – Embedded Trace. ARM Processor Cores: ARM7TDMI – ARM8 – ARM9TDMI – ARM10TDMI. Memory Hierarchy – Memory Size and Speed – ON-Chip Memory – Caches. Architecture Support for Operating System: ARM System Control Coprocessor – CP15 Protection Unit Registers – ARM MMU Architecture. ARM CPU Cores: ARM710T – ARM720T – ARM740T – ARM810 – Strong ARM SA-110.

TEXTBOOKS:

1. *Ramesh S Goankar, "Micropocessor Architecture: Programming and Applications with the 8085", Penram International, Fifth Edition, 2002.*
2. *Jochen Steve Furber, "ARM System-on-Chip Architecture", Addison Wesley Trade Computer Publications, Second Edition, 2000.*

REFERENCES:

1. *Douglas V Hall, "Microprocessor and Interfacing: Programming and Hardware", McGraw Hill Inc,. New Delhi 2002.*
2. *Kenneth L Short, "Microprocessors and Programming Logic", Prentice Hall of India, Second Edition.*
3. *Andrew Sloss, Dominic Symes and Chris Wright, "ARM System Developers Guide", Elsevier, Third Edition, 2004.*

15ECE311 DATA COMMUNICATION AND NETWORKS 3 0 0 3

Unit 1

Data Communication Concepts - Networks and open system standards - OSI reference model - Network layered architecture - Network topologies and the

physical layer - Bus/Tree topology - ring topology, star topology - Transmission media and technologies.

Unit 2

Protocol concepts - MAC layer - LAN and standards – MAN - WAN - Network routing - Public data networks – Circuit-switched data network - Packet-switched data network - Internet protocol - ISDN.

Unit 3

Network Interconnections - LAN-to-LAN connections - LAN-to-Host connections – Repeaters - Bridges - Routers and Gateways - Interconnection utilities - Electronic mail – VoIP – DNS – HTTP - Networks management- WLAN.

TEXTBOOK:

James Kurose and Keith Ross, "Computer Networking: A Top-Down Approach", 5th/6th Edition, Addison Wesley, 2010.

REFERENCES:

1. *Larry L. Peterson and Bruce S. Davie, "Computer Networks - A Systems Approach", Morgan Kaufmann, Fifth edition, 2011.*
2. *Andrew. S. Tannenbaum, DavidJ.Whetheral, "Computer Networks", Prentice Hall, Fifth Edition, 2010.*

15ECE312 DIGITAL COMMUNICATION 3 1 0 4

(Pre-requisite: 15ECE301 Communication Theory)

Unit 1

Introduction - Waveform Coding – PCM – DPCM - DM - Geometric representation of signal waveforms - Binary pulse modulation - Optimum receiver for binary modulated signals in additive white Gaussian noise - M-ary binary and orthogonal pulse modulation - Probability of error for binary and M-ary pulse modulation.

Unit 2

Digital Transmission through band limited channels - Signal design for band limited channels - Probability of error for detection of digital PAM - System design in the presence of channel distortion.

Unit 3

Transmission of digital information via carrier modulation - Amplitude modulated signals - Phase modulated signals - Quadrature amplitude modulated signals - Frequency modulated signals.

TEXTBOOKS:

1. *John G. Proakis and Masoud Salehi, "Fundamentals of Communication Systems", Pearson Education, First Edition, 2007.*

2. *Simon Haykin, "Digital Communications", Wiley India Private Limited, First Edition, 2006*

REFERENCES:

1. *Ziemer and Peterson, "Introduction to Digital Communication", Pearson Education, 2000.*
2. *B. Sklar, "Digital Communications", Pearson Education, Second Edition, 2006.*
3. *Amitabha Bhattacharya, "Digital Communication", Tata McGraw Hill Publishing Company, First Edition, 2006.*

15ECE313 VLSI DESIGN 3 0 0 3

(Pre-requisite: 15ECE202 Digital Circuits and Systems)

Unit 1

MOSFETs as switches - NMOS and CMOS physical layouts and stick diagrams. Physical structure of integrated circuits: NMOS and CMOS layers - Designing FET arrays - FET sizing and unit transistor - Physical design of logic gates and design hierarchies.

Unit 2

Analysis of MOS logic gates: DC switching characteristics of NMOS and CMOS inverters - DC characteristics of NAND and NOR gates - Transient response - Gate design for transient performance - Transmission gates and pass transistors.

Unit 3

Designing high speed CMOS logic networks: Gate delays - Driving large capacitive loads - Logical effort - BiCMOS drivers - Clocking and data flow control - Advanced techniques in CMOS logic circuits: Mirror circuits - Pseudo-NMOS - Tristate circuits - Clocked CMOS, Dynamic CMOS logic circuits.

TEXTBOOKS:

1. *J. P. Uyemura, "Introduction to VLSI Circuits and Systems", John Wiley and Sons, Second Edition, 2002.*
2. *David A Hodges, Horace Jackson, ResveSaleth, "Analysis and Design of Digital Integrated Circuits", McGraw Hill Publishing Company Limited, Third Edition, 2003.*

REFERENCES:

1. *Sung-Mo Kang, Yusuf Leblechi, "CMOS Digital Integrated Circuits - Analysis and Design", Tata McGraw Hill Publishing Company Limited, Third Edition, 2003.*
2. *Neil Weste, David Harris, Ayan Banerjee, "CMOS VLSI Design: A Circuits and Systems Perspective", Pearson Education, Third Edition, 2005.*

15ECE314 COMPUTER SYSTEM ARCHITECTURE 3 0 0 3

(Pre-requisite: 15ECE202 Digital Circuits and Systems)

Unit 1

Introduction to computer system - Brief history of computer systems - Fixed point arithmetic – Addition – Subtraction - Multiplication and division - Booth's algorithm -

Non-restoring division algorithm - Floating point arithmetic. Various addressing modes and designing of an Instruction set.

Unit 2

Data path and controller design - Introduction to CPU design - Processor organization - Execution of complete instruction - Design of control unit - Microprogrammed control unit.

Unit 3

Memory and system organization - Concepts of semiconductor memory - CPU-memory interaction - Organization of memory modules - Cache memory and related mapping and replacement policies - Virtual memory. Introduction to input/output processing: Programmed controlled I/O transfer - Interrupt controlled I/O transfer DMA - Secondary storage and type of storage devices - Introduction to buses - Introduction to RISC and CISC paradigm - Design issues of a RISC processor and example of an existing RISC processor - Introduction to pipelining.

TEXTBOOKS:

1. *John P. Hayes, "Computer architecture and Organisation", Tata McGraw-Hill, Third edition 1998.*
2. *V. Carl Hamacher, Zvonko G. Vranesic and Safwat G. Zaky, "Computer Organisation", Fifth edition, McGraw-Hill Inc, 1996.*

REFERENCES:

1. *Morris Mano, "Computer System Architecture", Prentice-Hall of India, 2000.*
2. *Behrooz Parhami, "Computer Architecture", Oxford Press.*
3. *P. Pal Chaudhuri, "Computer organization and design", 2nd Ed., Prentice Hall of India,2007.*
4. *G. Kane & J. Heinrich, "MIPS RISC Architecture", Englewood cliffs, New Jersey, Prentice Hall, 1992.*

15ECE315 BIOMEDICAL INSTRUMENTATION 3 0 0 3

Unit 1

Cell resting potential and action potentials - Origin of bio potentials - characteristics – Frequency and amplitude ranges - ECG – Einthoven's triangle – 3 lead ECG system - EEG – 10- 20 electrode system - Origin and characteristics of EMG – EOG - ERG electrodes and transducers. Electrode-electrolyte interface – Electrode – skin interface - Half cell potential – Impedance - Polarization effects of electrode – Nonpolarizable electrodes. Types of electrodes - Surface; needle and micro electrodes – ECG – EMG - EEG Electrodes.

Unit 2

Diagnostic and Therapeutic Equipments: Blood pressure monitors – Electrocardioscope - Pulse Oximeter - pH meter - Auto analyzer – Pacemakers –

Defibrillator - Heart lung machine - Nerve and muscle stimulators - Dialysis machines - Surgical diathermy equipments – Nebulizer; inhalator - Aspirator – Humidifier - Ventilator and spirometry.

Unit 3

Medical imaging techniques: Basics of diagnostic radiology – Production - Nature and properties of X rays - X-ray machine - Block diagram - Digital radiography – CT - Basic Principle - Block diagram – Radioisotopes in medical diagnosis – Physics of radioactivity – Gamma Camera. Block diagram – SPECT Scanner – PET Scanner - Principles of NMR Imaging systems - Block diagram of NMR Imaging System – Ultrasonic Imaging Systems – Physics of Ultrasound waves – Doppler effect – Medical Ultrasound Electrical safety: Physiological effects of electricity. Micro & macro shock hazards – Electrical Safety codes and standards – Protection of patients.

TEXTBOOK:

R S Khandpur, "Handbook of Biomedical Instrumentation", 1st ed., Tata McGraw Hill Publishing Company Limited, 2004.

REFERENCES:

1. *John G Webster, "Medical Instrumentation - Application and Design", 4th ed., John Wiley and Sons, 2007.*
2. *Leslie Cromwell, Fred. J. Weibell, Erich. A. Pfeiffer, "Biomedical Instrumentation & Measurements, 2nd ed., Pearson Education., 2001.*

15ECE320 ACTIVE FILTER DESIGN 3 0 0 3

(Pre-requisite: 15ECE303 Linear Integrated Circuits)

Unit 1

Introduction to Active Filtering - Categories of Filters - LP, HP, BP, BE and All Pass Filters - Second Order s-domain equations in each case and their pole-zero plots. Filter approximations – Butterworth, Chebyshev, Elliptic and Bessel - Phase and group delay characteristics of approximation functions - Delay equaliser functions - Frequency transformations.

Unit 2

Review of opamp characteristics: Single opampbiquads - First order LP, HP, BP, All pass filters - Biquad topologies - Analysis and design of single opamp Biquads with finite gain. Analysis and design of LP, HP and BP filter with second order response. Use of bridged T network in active Filters - Sensitivity analysis of single opamp filters.

Unit 3

Multiple opamp Filters: KHN (Universal Active Filter) filter, Tom-Thomas biquad -

Analysis and design for various categories of filters - Q enhancement and pole frequency error problem - Elementary ideas of compensation.

TEXTBOOK:

R Schaumann and M E Van Valkenburg, "Design of analog filters", First Edition, Oxford University Press, 2005.

REFERENCES:

1. *G Daryanani, "Principles of active network synthesis and design", New York, Wiley, 1976.*
2. *M Van Valkenburg, "Analog filter design", New York, Holt Rinehart and Winston, 1982.*
3. *Franco S., "Design with operational amplifiers and analog integrated circuits", 3rd ed. New York, McGraw-Hill, 2002.*
4. *Allan Waters, "Active filter design", New York, McGraw-Hill, 1991.*

15ECE321 ADAPTIVE SIGNAL PROCESSING 3 0 0 3

(Pre-requisite: 15ECE212 Signal Processing II)

Unit 1

Adaptive Systems - Definition and characteristics – Properties - Applications and examples of an adaptive system. Stochastic Processes and Models: Characterization - Mean ergodic theorem - Correlation matrix - Stochastic models - Power spectral density - Properties of power spectral Density - Linear transformations - Power spectral estimation.

Unit 2

Wiener filters - Linear optimum filtering - Minimum mean-square error - Wiener-Hopf equations - Multiple linear regression model - Steepest-descent algorithm - Linear prediction - Forward linear prediction, Levinson-Durbin algorithm. Kalman filter - Extended kalman filter.

Unit 3

Least-Mean-Square (LMS) adaptive filters - LMS algorithm, LMS adaptation algorithm - applications. Method of Least Squares - Data windowing, Normal equations and linear least square filters, Recursive least squares algorithm.

TEXTBOOK:

Simon Haykins, "Adaptive Filter Theory", Pearson Education, Fifth Edition, 2013.

REFERENCES:

1. *Todd K. Moon, Wynn C. Stirling, "Mathematical Methods and Algorithms for Signal Processing" Prentice Hall, First edition, 1999.*
2. *John. R. Triechler, C. Richard Johnson (Jr), Michael. G. Larimore, "Theory and Design of Adaptive Filters", Prentice Hall India Private Limited, 2004.*
3. *Bernard Widrow and Samuel. D. Stearns, "Adaptive Signal Processing", Pearson Education, 2001.*

15ECE322 ANALOG SIGNAL PROCESSING 3 0 0 3

Unit 1

Review of transistor characteristics- bias stability- compensation techniques - frequency response of cascaded amplifiers - theory of compensation - dominant pole and pole-zero compensation techniques - two-stage MOS amplifier compensation - bandwidth limitation of amplifiers - single transistor and differential mode wide-band video amplifiers - tuned amplifier design - stabilization and applications.

Unit 2

Universal Active filter - simulation of differential equations - inductor and negative simulations - double integrator and gyrator oscillators - Analog Multipliers - Log-Antilog Multipliers - AGC/AVC - Low-drift and Low-input-current specifications - origin of slew rate limitations - improving slew rate in MOS Op-amps.

Unit 3

Switched-Capacitor circuits - MOSFEs as switche s- Switched-Capacitor integrators - Switched-Capacitor amplifiers - Unity gain buffer - Non-inverting amplifier - Precision multiply-by-two circuit.

TEXTBOOKS:

1. *Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley Publishers, Fifth Edition, 2009.*
2. *Sedra and Smith,"Microelectronic Circuits", Oxford Press, 2004, Fifth Edition.*

15ECE323 AVIATION ELECTRONICS 3 0 0 3

Unit 1

Introduction to avionics - Systems design parameters and specifications - Traceability - Ilities - Avionics architecture - LRU/LRM - Backplane standards - Data bus – topologies - word formats - MIL-STD 1553B - ARINC 429 - ARINC 629 - CSDB – FCAD.

Unit 2

Fault diagnosis methodologies - FMEA - FTA - Fault tolerance and recovery - NOTAM - Practical exercises.

Unit 3

New avionics systems - Cockpit instruments - User interface - Navigation - Guidance and Flight Control - Stores management system - Data communications.

TEXTBOOKS:

1. *Albert Helfrick, "Principles of Avionics, Airline Avionics", Fourth edition, 2007*
2. *Keith W. Bose, "Aviation Electronics", Howard W. Sams& Company Inc., 1981.*

REFERENCES:

1. *Ian Moir, Allan Seabridge, "Aircraft Systems: Mechanical, electrical, and avionics subsystems integration", Professional Engineering Publishing Limited, London and Bury St Edmunds, UK, 2001.*
2. *Cary R. Spitzer, "The Avionics Handbook", CRC Press, 2001 Qiping Chu et al., Advances In Aerospace Guidance, Navigation and Control, Springer, 2013.*

15ECE324 BIOMEDICAL IMAGE PROCESSING 3 0 0 3

(Pre-requisite: 15ECE212 Signal Processing II)

Unit 1

Objectives of biomedical image analysis - Computer aided diagnosis - Nature of medical images: X-ray imaging – Tomography - Nuclear medicine imaging - SPECT imaging - Positron imaging tomography – Ultrasonography - Magnetic resonance imaging. Removal of artifacts - Space domain filters - Frequency domain filters - Optimal filtering - Adaptive filters.

Unit 2

Image enhancement – Gray level transforms - Histogram transformation - Convolution mask operators - Contrast enhancement. Detection of regions of interest - Thresholding and binarization - Detection of isolated lines and points - Edge detection - Region growing.

Unit 3

Analysis of shape and texture - Representation of shapes and contours - Shape factors - Models for generation of texture - Statistical analysis of texture - Fractal analysis - Fourier domain analysis of texture - Segmentation and structural analysis of texture. Pattern classification and diagnostic decision - Measures of diagnostic accuracy - Applications: Contrast enhancement of mammograms - Detection of calcifications by region growing - Shape and texture analysis of tumours.

TEXTBOOKS:

1. *Sinha G. R, Patel, B. C., "Medical Image Processing: Concepts And Applications", Prentice Hall, 2014.*
2. *Gonzalez R C, Woods R E, "Digital Image Processing", Third Edition, Prentice Hall, 2007.*

REFERENCES:

1. *Rangayyan R M, "Biomedical Image Analysis", Fifth Edition, CRC Press, 2005.*
2. *KayvanNajarian, Robert Splinter, "Biomedical Signal and Image Processing", Second Edition, CRC Press, 2014.*
3. *Deserno T M, "Biomedical Image Processing", Springer, 2011.*

15ECE325 BIOMEDICAL SIGNAL PROCESSING 3 0 0 3

(Pre-requisite: 15ECE212 Signal Processing II)

Unit 1

Signal processing: Review of Discrete time signals and systems - LTI systems - Response of LTI systems – Convolution - Difference equation representation of discrete systems Z transform - Transform analysis of LTI system – DFT. STFT - Introduction to wavelets - CWT and DWT with Haar wavelet. Introduction to biosignals: Computers in medicine. Human anatomy and physiology - Cell structure - Origin of bioelectric potentials - Biomedical signals - The Brain and its potentials. Electrophysiological origin of brain waves. EEG signal and its characteristic- ECG signal origin and characteristics.

Unit 2

Neurological signal processing: EEG analysis - Parametric modelling - Linear prediction theory; Autoregressive (AR) method; Recursive estimation of AR parameters. Cardiological signal processing: ECG parameters and their estimation - Arrhythmia analysis monitoring - ECG data reduction techniques.

Unit 3

Adaptive interference / Noise cancellation: Types of noise in biosignals; Digital filters - IIR and FIR - Notch filters - Optimal and adaptive filters. Weiner filters - steepest descent algorithm - LMS adaptive algorithm - Adaptive noise canceller - cancellation of 50 Hz signal in ECG - Cancellation of maternal ECG in foetal electrocardiography.

TEXTBOOKS:

1. *D. C Reddy, "Biomedical Signal Processing, Principles and Techniques", Tata McGraw Hill Publishing Company Limited, First Edition, 2005.*
2. *Willis J Tompkins, "Biomedical Digital Signal Processing", Prentice Hall India Private Limited, First Edition, 2006.*

REFERENCES:

1. *Rangaraj M Rangayyan "Biomedical Signal Analysis – A case study approach" IEEE press series in biomedical engineering, First Edition, 2002.*
2. *John G Proakis, Dimitris and G. Manolakis, "Digital Signal Processing Principles algorithms, applications" PHI Third Edition. 2006*

15ECE326 BIOMETRIC SYSTEMS 3 0 0 3

Unit 1

Introduction: Benefits of biometric versus traditional techniques – Key biometric terms and processes – Verification and identification - Enrollment and template creation - Biometric matching. Accuracy in biometric systems: False match rate -

False non-match rate - Failure-to-enroll rate - Derived metrics - Equal error rate - Ability-to-verify rate.

Unit 2

Physiological biometrics: Finger scan – Facial scan – Iris scan – Components - Working principles - Competing technologies - Strengths and weaknesses – Automated fingerprint Identification systems. Behavioural biometrics signature scan – Keystroke scan – Components - Working principles - Strengths and weaknesses.

Unit 3

Biometric applications: Categorizing biometric applications - Criminal identification - Citizen identification – Surveillance – PC/network access – Physical access/time and attendance - Customer facing applications - E-commerce/telephony – Retail/ ATM/point of sale applications. Biometric markets: Law enforcement - government sector - Financial sector – Healthcare - travel and immigration - Biometric standards.

TEXTBOOK:

Samir Nanavati, Michael Thieme, Raj Nanavati, "Biometrics – Identity Verification in a Networked World", Wiley-dreamtech India Pvt Ltd, New Delhi, 2003.

REFERENCES:

1. *James Wayman, Anil Jain, David Maltoni, Dario Maio (Eds), "Biometric Systems", Springer International Edition, 2004.*
2. *Anil K Jain, Patrick Flynn, Arun A Ross, "Handbook of Biometrics", Springer, 2008.*
3. *John R Vacca, "Biometric Technologies and Verification Systems", Elsevier Inc, 2007.*
4. *Ruud M. Bolle, SharathPankanti, Nalini K. Ratha, Andrew W.Senior, Jonathan H. Connell, "Guide to Biometrics", Springer, 2009.*

15ECE327 DIGITAL SIGNAL PROCESSORS AND APPLICATIONS 3 0 0 3

(Pre-requisite: 15ECE212 Signal Processing II)

Unit 1

Programmable architecture: Review of digital signal processing concepts - Basic architectural features - DSP communicational building blocks - Bus architecture and memory data addressing capabilities - Address generation unit - Programmability and program execution - Speed issues - Features for external interfacing.

Unit 2

Programmable digital signal processors: Commercial digital signal processing devices - Data addressing modes of TMS320C54XX digital signal processors - Data addressing modes of TMS320C54XX processors - Memory space of TMS320C54XX processors - Memory space of TMS320C54XX processors - Program control - TMS320C54XX instruction & programming - On-chip peripherals - Pipeline operation of TMS320C54XX processors.

Unit 3

Implementation of basic DSP algorithms: The Q notation - FIR filters - IIR filters interpolation of filters. Decimation filters - Adaptive filters - 2-D signal processing - FFT algorithm for DFT computation - Butterfly computation overflow and scaling - Bit reversed index generation FFT implementation on the TMS320C54XX - Computation of signal spectrum. Advanced DSPs: Overview of TMS320C67X processor: Architecture - pipelining - Applications of programmable DSP devices to speech/image processing.

TEXTBOOK:

Avtar Singh, S. Srinivasan, "Digital Signal Processing Implementation", Thomson Learning Inc, First Edition, 2004.

REFERENCES:

1. *Emmanuel C. Fletcher, Jervis B. W. "Digital Signal Processing: A Practical Approach", Pearson education, Second Edition, 2002.*
2. *B. Venkataramani, M. Bhaskar, "Digital Signal Processors - Architecture, Programming and Applications", Tata McGraw Hill Publishing Company Limited, First Edition, 2007.*

15ECE328 HYPERSPECTRAL IMAGING ANALYSIS 3 0 0 3

(Pre-requisite: 15ECE212 Signal Processing II)

Unit 1

Introduction to Remote Sensing: Multi-Spectral Imagery (MSI) - Hyperspectral Imagery (HSI) - Scientific Principles: Physics of imaging spectroscopy - electromagnetic propagation - sensor physics - atmospheric Corrections - Hyperspectral Concepts and System Tradeoffs: Signal-to-Noise ratio (SNR) - spectral resolution– sampling – range.

Unit 2

Dispersion Techniques – data collection systems – current HIS systems: Ground – airborne – spaceborne – calibration techniques – HSI Data Processing Software – HSI Data Processing Techniques: Image Space – spectral space - feature space, spectral angle mapping - N-dimensional scatterplots - projection pursuit – spectral mixture analysis – Principal Component Analysis (PCA).

Unit 3

Spectral mapping – Pixel Purity Index (PPI) – Minimum Noise Fraction (MNF) – Mixture Tuned Matched Filtering (MTMF) – Classification Techniques: Supervised – Unsupervised – Hybrid - Detection, Classification, and Quantification in Hyperspectral Images Using Classical Least Squares Models.

TEXTBOOK:

Chein-I-Chang, "Hyperspectral Techniques for Spectral Detection and Classification Graphics and General-Purpose Computation," Kluwer Academic Publishers, 2003.

REFERENCES:

1. *James B. Campbell and Randolph H. Wynne, "Introduction to Remote Sensing", Guilford Press, Fifth Edition, 2011.*
2. *Hans F. Grahn and Paul Geladi, "Techniques and Applications of Hyperspectral Image Analysis, "John Wiley & Sons Ltd, 2007.*

15ECE329 IMAGE ANALYSIS 3 0 0 3

(Pre-requisite: 15ECE212 Signal Processing II)

Unit 1

Review of basics of image processing - Image restoration - Image segmentation: Thresholding – Edge-based segmentation – Region based segmentation - Matching - Evaluation issues in segmentation - Image morphology - Basic morphological concepts - Dilation and erosion - Skeletons and object marking - Granulometry - Morphological segmentation and watersheds.

Unit 2

Image representation and description - Chain Codes - Polygonal approximations using minimum perimeter polygons - Other polygonal approximation – Approaches – Signatures - Boundary descriptors - Regional descriptors - Use of principal components for description- Introduction to object recognition.

Unit 3

Applications: Medical image analysis. Medical imaging modalities: Planar X-Ray imaging - X-Ray computed tomography - Magnetic resonance imaging - Nuclear imaging - Ultrasonography. Document Image Analysis: Document Image binarization - Noise reduction - Document cleaning - Text segmentation - Optical character recognition.

TEXTBOOK:

Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Third Edition, Pearson Education India, 2009.

REFERENCES:

1. *Geoff Dougherty,"Medical Image Processing Techniques and Applications", Springer, 2011.*
2. *L. O. Gorman and R. Kasturi, "Document Image Analysis", IEEE Computer Society Press, 1995.*

15ECE330 IMAGE PROCESSING 3 0 0 3

(Pre-requisite: 15ECE212 Signal Processing II)

Unit 1

Review of matrices - Vector spaces - Probability and random variables - Origin of digital image processing: Examples of fields that use digital image processing - Elements of visual perception brightness and contrast - Image sensing and acquisition - Image sampling and quantization - Some basic relationships between

pixels. Image Enhancement in spatial domain: Some basic gray level transformations - Histogram processing - Enhancement using arithmetic/logic operations - Basics of spatial filtering - Smoothing and sharpening spatial filters.

Unit 2

Image enhancement in frequency domain: Review of sampling and discrete fourier transform - Image enhancement in the frequency domain. Frequency domain filtering: Smoothing – Sharpening - Homomorphic filtering. Color image processing fundamentals: Pseudo color image processing- Basics of full color image processing.

Unit 3

Image Compression: Image compression models – Error free compression- Lossy compression – Applications of image compression. Image transforms: Introduction to transformation used for image processing applications -Cosine – Hadamard – Haar – Sine - KL Transforms and their properties.

TEXTBOOK:

Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Third Edition, Pearson Education India, 2009.

REFERENCE:

Anil K. Jain, "Fundamentals of digital image processing" Prentice Hall of India Private Limited, 1996.

15ECE331 PATTERN RECOGNITION TECHNIQUES AND ALGORITHMS 3 0 0 3

(Pre-requisite:15MAT213 Probability and Random Processes)

Unit 1

Statistical decision making techniques: Bayes' theorem - Multiple features - Conditionally independent features - Decision boundaries - Unequal costs of error - Estimation of error rates - Leaving one out technique - Characteristic curves.

Unit 2

Non-parametric decision making techniques: Histograms - Kernel and window estimators - Nearest neighbor classification techniques - Adaptive decision boundaries - Adaptive discriminant functions - Minimum squared error discriminant functions - Choosing a decision making technique.

Unit 3

Artificial neural networks: nets without hidden layers - Nets with hidden layers - Back propagation algorithm - Hopfield nets.

TEXTBOOK:

Earl Gose, Richard Johnsonbaugh, Steve Jost, "Pattern Recognition and Image Analysis", PHI Learning Private Ltd., New Delhi, 2009.

REFERENCES:

1. *Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", Third Edition, Morgan Kaufmann Publishers (Elsevier), 2011.*
2. *K. P Soman, Shyam Diwakar, V. Ajay, "Insight into Data Mining: Theory and Practice", PHI Learning Private Ltd., New Delhi, 2006.*
3. *Sergios Theodoridis, Konstantinos Koutroumbas,"Pattern Recognition", Fourth Edition, Academic Press (Elsevier), 2011.*

15ECE332 SPARSE SIGNAL AND IMAGE PROCESSING 3 0 0 3

(Pre-requisite:15ECE212 Signal Processing II)

Unit 1

Review of Mathematical Preliminaries, signals and systems course: Review of matrices - vector spaces and linear algebra - Linearly independent - Vector norms – Orthogonality - Eigen values - Eigen vectors - Covariance of matrices – Vector/ function space - Basis function - Orthogonal basis by sampling sine and cosine functions - Singular value decomposition. Significance of time-frequency domains – convolution - Fourier series - Fourier transforms - Review of Fourier theory and properties of fourier transform – DFT-FFT.

Unit 2

Introduction to image processing and wavelet transform: The origins of digital image processing - Examples of fields that use digital image processing - Image digitization and sampling - Image sensing and acquisition - Image sampling and quantization - Image enhancement - Image compression. Continuous wavelet transform (CWT) - Discrete wavelet transform - Haar scaling function nested spaces - Signal decomposition and signal reconstruction using (DWT).

Unit 3

Compressed sensing and Sparse Signal Representation: Sparse signals - Single-pixel imaging - Compressible signals - over complete dictionaries - Coherence between bases - Compressed sensing and signal reconstruction - Restricted isometry property - Unconstrained and constrained optimization algorithms – Applications of compressed sensing in different fields.

TEXTBOOK:

K. P. Soman and R. Ramanathan, "Digital signal and Image Processing - The sparse way", Elsevier India. 2012.

REFERENCES:

1. *K. P. Soman, K. I. Ramachandran, "Insight into Wavelets: From Theory to Practice", PHI, 2004.*
3. *Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Third Edition, Pearson Education India, 2009.*
4. *Yonina C. Eldar, Gitta Kutyniok, "Compressed Sensing: Theory and Applications", Cambridge university press, 2012.*

15ECE333 SPOKEN LANGUAGE PROCESSING 3 0 0 3

(Pre-requisite: 15ECE212 Signal Processing II)

Unit 1

Speech analysis: source filter modeling - Speech sounds - Lip radiation - Linear prediction - Lattice filters - Levisnon-Durbin recursion. Feature extraction for speech processing: Short term Fourier transform – Wavelets – cepstrum - Sinusoidal and harmonic representations - Mel frequency cepstral coefficients (MFCC) - Perceptual linear prediction (PLP) - Mel filter bank energies.

Unit 2

Principles of speech coding: Main characteristics of a speech coder - Key components of a speech coder - From predictive coding to CELP - Improved CELP coders - Wide band speech coding - Audio-visual speech coding. Speech synthesis: Linguistic processing - Acoustic processing - Training models automatically - Text pre-processing - Grapheme to phoneme conversion – Rule based and decision tree approaches - Syntactic prosodic analysis - Prosodic analysis - Speech signal modeling.

Unit 3

Principles of speech recognition: Hidden Markov models (HMM) for acoustic modeling, Observation probability and model parameters - HMM as probabilistic automata - Viterbi algorithm - Language models - n-gram language modeling and difficulties with the evaluation of higher order n-grams and solutions. Spoken keyword spotting approaches - Evaluation metric - Spoken language identification – Approaches – Acoustic – Phonotactic - LVCSR based.

TEXTBOOKS:

1. *Joseph Mariani (Ed), "Spoken Language Processing", John Wiley & Sons, 2009.*
2. *Xuedong Huang, Alex Acero, Hsiao-Wuen Hon, "Spoken Language Processing, A guide to theory, algorithm and system development", Prentice Hall, Inc, New Joursey, USA, 2001.*

REFERENCE:

J Benesty, M MSondhi, Y. Huang (Eds.), "Springer Handbook on Speech Processing", Springer-Verlag Berlin, Heidenberg, 2008.

15ECE334 WAVELET - BASED SIGNAL PROCESSING AND APPLICATIONS 3 0 0 3

(Pre-requisite: 15ECE212 Signal Processing II)

Unit 1

Review of mathematical preliminaries: Vector - Function space - Basis function - Review of fourier theory and properties of fourier transform - Short time fourier transform - Heisenberg's uncertainty principle - Continuous wavelet transform – CWT and its Properties – DWT - Time-frequency tiling.

Unit 2

Discrete Wavelet Transform - Haar scaling function - Nested spaces - Wavelet function. Designing orthogonal wavelet systems: Daubechies – Coiflet - Symlet wavelet system coefficients - Signal decomposition using DWT - Relation to filter banks and frequency response - Signal reconstruction using DWT – M band wavelets.

Unit 3

Introduction to bi-orthogonal wavelets - Introduction to lifting scheme- Applications ofwavelet transform: Image processing - Image compression - De-noising - audio coding - channel coding.

TEXTBOOK:

K. P. Soman, K. I. Ramachandran, "Insight into Wavelets: From Theory to Practice", Third Edition, PHI, 2004.

REFERENCES:

1. *Gilbert Strang and Truong Nguyen, "Wavelets and Filter banks", Wellesley Cambridge Press, 1996.*
2. *R. M. Rao and Ajit S. Bopardikar, "Wavelet Transform, Introduction to theory and Applications", Addison-Wesley, 1998.*

15ECE337 ANALOG AND MIXED CIRCUIT DESIGN 3 0 0 3

Unit 1

Overview of MOFSET basics – Second order effects – Measurement of parameters for a given technology with a simulation tool – Passive and active current mirrors – Single stage amplifier – Differential voltage and current amplifiers – Noise performance of elementary transistor stages – Systematic design of operational amplifiers.

Unit 2

Mixed Signal Circuits: Non-linear analog circuits - Open loop comparators – static and dynamic comparators, effect of positive feedback and stability issues – Switched capacitor circuits. Nonlinearity and Mismatch – capacitor nonlinearity, effect of feedback on nonlinearity, linearization techniques – offset cancellation techniques – reduction of noise by offset cancellation.

Unit 3

Data convertors: Fundamental of data converters - static characteristics – INL, DNL – Dynamic characteristics – SNR, SFDR, SINAD – DAC architectures: Resistive – Capacitive – Current steering. ADC Architectures: Flash – SAR – Pipeline ADC.

TEXTBOOKS:

1. *Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Tata McGraw Hill, 2003.*
2. *Franco Maloberti, "Data Convertors", Springer, 2007.*

REFERENCES:

1. *Willy M. C Sansen, "Analog Design Essentials", Springer,2006.*
2. *Behzad Razavi, "Principles of Data Conversion System Design", IEEE Press,1995.*

15ECE338 ANALOG IC DESIGN 3 0 0 3

(Pre-requisite: 15ECE211 Electronic Circuits)

Unit 1

Introduction to Analog Integrated Circuits: Analog Integrated Circuit design, Notation, Symbols and Terminology, Analog Signal processing, Example of Analog VLSI mixed signal Circuit Design. CMOS Technology: Basic MOS semiconductor fabrication process, PN junction, The MOS Transistor, Passive Components, Other Considerations of CMOS Technology, Integrated Circuit Layout - CMOS Device Modeling, Simple MOS Large Signal Model, Other MOS Large Signal Model Parameter, Small Signal Model for the MOS Transistor, Computer Simulation Model, Sub threshold MOS model, SPICE Simulation of MOS Circuit.

Unit 2

Analog CMOS Sub circuits: MOS Switch, MOS Diode /Active Resistor, Current sinks and sources, current mirror. Frequency response of MOS amplifiers. Large signal and small signal analysis of Differential amplifier.

Unit 3

CMOS Operational Amplifier: Introduction and analysis of Cascode Amplifier and Telescopic Cascode Amplifier. Design of CMOS op-amps, Compensation of op-amps, Design of Two stage op-amps, Cascode op-amps.

TEXTBOOK:

P. Allen and D. Holberg, "CMOS Analog Circuit Design", Oxford University Press, Second Edition, 2012.

REFERENCES:

1. *B. Razavi, "Design of Analog CMOS Integrated Circuits", McGraw Hill, 2003.*
2. *Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley Publishers, Fifth Edition, 2009.*

15ECE339 APPLICATIONS OF LINEAR INTEGRATED CIRCUITS 3 0 0 3

(Pre-requisite: 15ECE303 Linear Integrated Circuits)

Unit 1

Current Sources and Operational Amplifiers: Current mirror - Wilson Current Mirror - Widlar Current Source - Current Sources in IC Form. Op-amp basics; ?A741 – Internal schematic - Parameters - Frequency compensation of voltage and current feedback amplifiers - Grounding and shielding.

Unit 2

Op-amp CircuitsI: Instrumentation amplifiers - Current Sources using opamps - Isolation Amplifiers - Operational transconductance amplifiers (OTA) - Log and anti-log amplifiers – Multipliers - Voltage to frequency and frequency to voltage converters - Phase sensitive detectors (PSD) - Phase locked loops (PLL) - Lock-in amplifiers;

Unit 3

Op-amp circuits II: Voltage references - Low noise current differencing and low power operational amplifiers - Power supply ripple - Voltage regulators - IC protection circuits - Analog to digital converters - Σ–Δ ADC.

TEXTBOOKS:

1. *Franco S., "Design with operational amplifiers and analog integrated circuits", Third Edition, New York McGraw-Hill, 2002.*
2. *Sedra A and Smith K C, "Microelectronic circuits", Sixth Edition, New York Oxford University Press, 2010.*

REFERENCES:

1. *Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Tata McGraw Hill, 2003.*
2. *Graeme J., Tobey G., and Huelsman L. P., "Operational amplifiers - Design and Applications", New York McGraw-Hill, 1971.*
3. *Soclof S, "Applications of analog integrated circuits", Englewood Cliffs, NJ: Prentice-Hall, 1985.*
4. *Relevant Datasheets from Texas Instruments, Maxim and Harris Semiconductors.*

15ECE340 INTEGRATED CIRCUITS FOR BIOLOGICAL SYSTEMS 3 0 0 3

(Pre-requisites: 15ECE303 Linear Integrated Circuits; 15ECE302 Control Systems Engineering)

Unit 1

Introduction: Bio-signals, Bio-potentials: neural, cardiac, muscular, Chemical, optical signals. Role of amplifiers - Analog and digital signals – Frequency-response band and interfacing.The basic linear feedback loop, Connections between feedback

loops and circuits, Root-locus techniques, Eight root-locus rules, Thezeros of a closed-loop system.

Unit 2

Device physics (MOS), Operating regimes, Large signal model - Parasitics, Small signal model, Transconductance, Impedances, Common Source (CS) Amplifier-Gain, Biasing, Interfacing CS to Biology, Diff. Amp. for Noisy Electrodes – Common/ differential mode signals – Common-mode rejection ratio, Common drain (voltage in, current out) - Common gate (current in, voltage out), Current in, current out-Biasing circuits Op-amps-two stage, frequency compensation, sources of noises, Power spectral density,noise in op-amp, Minimum detectable signal.

Unit 3

Design and simulation of ECG Pre-amplifier, High CMRR OP-Amp design, instrumentation amplifier, design and simulation of CMOS filters for low frequency ranges. Advanced process design, fabrication and testing of transistors for analog integrated circuits.

TEXTBOOKS:

1. *Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Tata McGraw Hill, 2003.*
2. *Gary. S. May and S. M. Sze, "Fundamentalsof semiconductor fabrication", John Wiley, First Edition, 2003.*

REFERENCES:

1. *T. Chan Carusone, D. Johns, and K. Martin, "Analog Integrated Circuit Design", 2nd edition, J. Wiley & Sons, 2011.*
2. *P. Allen and D. Holberg, CMOS "Analog Circuit Design", 2nd edition, Oxford University Press, 2002.*
3. *P. Gray, P. Hurst, S. Lewis, and R. Meyer, "Analysis and Design of Analog Integrated circuits", John Wiley and Sons, Fifth Edition, 2009.*
4. *Rahul Sarpeshkar,"Ultra Low Power Bioelectronics Fundamentals, Biomedical Applications and Bio-inspired Systems", 1st edition Cambridge University Press 2010*
5. *Myer Kutz, The-Bio-Medical-Engineering and Handbook.*

15ECE344 ANTENNA SYSTEMS AND DESIGN 3 0 0 3

Unit 1

Introduction to radiation concept – Antenna parameters – Directivity – Gain – Radiation pattern – Impedance - Polarization – Beamwidth – Antenna temperature – Antenna measurements and Requirement for measurements.

Unit 2

Types of antennas – Point source – Dipole and slots – Loop antenna – Horn antenna – Helical Antenna – Patch – Reflector antennas –Parabolic reflector.

Unit 3

Array of two sources – Pattern multiplication – Linear arrays – Broadside array – Endfire array – Planar arrays.

TEXTBOOK:

Kraus, Marhefka, "Antennas for all Applications", Tata McGraw Hill, Third Edition, 2002.

REFERENCES:

1. *Vincent F. Fusco, "Foundations of Antenna Theory and Techniques", Pearson Education, First Impression, 2007.*
2. *C. A. Balanis, " Antenna Theory – Analysis and Design", Wiley India, 2000*

15ECE345 CELLULAR AND MOBILE COMMUNICATION SYSTEM 3 0 0 3

Unit 1

Introduction to cellular mobile systems - Basic Cellular System - Cellular communication infrastructure: Cells – Clusters - Cell Splitting - Frequency reuse concept and reuse distance calculation - Cellular system components - Operations of cellular systems – Handoff/Handover - Channel assignment - Fixed and dynamic - Cellular interferences: Co-Channel and adjacent channel and sectorization.

Unit 2

Channel Models: Properties of mobile radio channels - Intersymbol interference - Multipath and fading effects - Interleaving and diversity - Multiple access schemes (TDMA, FDMA, CDMA, SDMA) - Interuser interference - Traffic issues and cell capacity - Power control strategies - Channel assignment - Handoff.

Unit 3

Introduction to modern cellular standards - 2G Architecture such as GSM and CDMA based - 2.5G - GPRS: GPRS and its features - GPRS network architecture - GPRS protocol architecture - GPRS backbone network - 3G standard details such as UMTS - Introduction to LTE.

TEXTBOOKS:

1. *Theodore S. Rappaport, "Wireless Communications Principles and Practice", Second Edition, 2002.*
2. *Gottapu Sasibhushana Rao, "Mobile Cellular Communication" Pearson Education, 2012.*

REFERENCES:

2. *Andrea Goldsmith, "Wireless Communications", Cambridge University Press, First Edition, 2005.*
3. *William Stallings, "Wireless Communication and Networking", PHI, 2003.*

15ECE346 DIGITAL TELEPHONY 3 0 0 3

Unit 1

Telephony Background: An overview of telephone networks - Transmission system - Basic switching system – Signaling - Echo cancellation - Working principles of telephone - DC (pulse) and DTMF (tone) – Signaling - Digital Switching Systems. Traffic Analysis: Traffic characterization - Loss systems - Network blocking probabilities - Delay systems (queuing system) - Queues in tandem.

Unit 2

Switching: Single stage – Grading - Progressive grading - Traffic capacity of grading – Applications - Link systems. Space/Time Division Switching: Space switch - Time switch and their design - Hybrid switches - Concentrator and switching components - PBX switches - Digital cross connect - Time division switching: Space and time division switching - General space switches - Time switches - Time division switching networks - Basic networks - Bidirectional pass - Complex switching networks – Concentrators - PBX switches - Digital cross connect units - Grades of services of time division switching networks.

Unit 3

Switching Control: Call processing - Signal exchanges - Signal operations - Common control – Reliability - Availability and security - Network synchronization - Network control network management. Digital Network and Signaling: Integrated service digital network (ISDN) - ISDN overview - ISDN interfaces and functions - User network interface - ISDN protocol architecture. Signaling System Number 7 (SS7): SS7 architecture signaling date link level - signaling link level - Network level - Signaling connection control part.

TEXTBOOKS:

1. *J E Flood, "Telecommunication Switching, Traffic and Networks", Pearson Education, 2003.*
2. *John C Bellamy, "Digital Telephony", Third Edition, John Wiley and Sons, 2002*

REFERENCES:

1. *William Stalling, "ISDN and Broadband ISDN with Frame Relay and ATM", Fourth Edition, Pearson education Asia publication.*
2. *Thiagarajan Viswanathan, "Telecommunication Switching and Networks", PHI Publication.*

15ECE347 INTRODUCTION TO RADAR SYSTEMS 3 0 0 3

Unit 1

Introduction to Radar: Radar block diagram - Radar frequencies - Applications of radar - Radar range equation - Minimum detectable signal - Receiver noise - Integration of radar pulses Radar cross section of targets - Pulse repetition frequencies and range ambiguities.

Unit 2

Radar Components: Radar antennas - Review of antenna parameters - Parabolic reflector antennas - Scanning feed reflector antennas - Lens antenna - Cosecant squared antenna pattern - Radomes. Radar receivers: Noise figure in receivers – Mixers – Displays - Duplexers.

Unit 3

Radar Types: CW and FM modulated radar: Doppler effect - CW radar - FM CW radar - multiple frequency CW radar. MTI and pulse Doppler radar: Delay line cancellers - Staggered PRF - Pulse Doppler radar - MTI from a moving platform. Tracking radar: tracking using a radar - Sequential lobing conical scan - Monopulse tracking radar - Target reflection and angular accuracy - Tracking in range - Acquisition.

TEXTBOOKS:

1. *Meril I Skolink,"Introduction to Radar Systems", Tata–McGraw Hill (Third Edition), 2003*
2. *C.A Balanis, "Antenna Theory: Analysis and design", John Willey & Sons,2000.*

REFERENCES:

1. *Mark A Richards, James A Scheer, William A Holm,"Principles of modern radar", Sci. Tech Publishing incorporated, 2010.*
2. *Jerzy M Kawecki, "Radar Essentials", IEEE Press 2000.*

15ECE348 MICROSTRIP DEVICES AND CIRCUITS 3 0 0 3

(Pre-requisite: 15ECE213 Transmission Lines and Waveguides)

Unit 1

Introduction to planar transmission lines: stripline – Microstrip line – Shielded microstripline – Impedance – Effect of thickness – Attenuation - Applications. Distributed and lumped elements - Capacitors – Inductors – Resistors – Terminations – Attenuators – Resonators. Directional couplers: Rring directional couplers - Branch-line directional couplers.

Unit 2

Power dividers, combiners and Y junctions: Power dividers – Combiners – Quarter wave length power dividers / combiners – N-way dividers / combiners – Ferrite devices – Circulators – Isolators - Non-ferrite nonreciprocal devices. Diode control devices: Pin diode parameters – Switches – Attenuators.

Unit 3

Microstrip circuits: Microwave integrated subassemblies – l band multifunctional transmit / receive module – Electrically tunable preselector – Switchable balanced amplifier - Design and fabrication technology – RF/microwave packages - Metal – Ceramic – Plastic – 3D design.

TEXTBOOK:

Leo G. Maloratsky, "Passive Rf& Microwave Integrated Circuits", Elsevier Inc, First Edition, 2006.

REFERENCES:

1. *David M. Pozar, "Microwave Engineering", Wiley India Limited, Third Edition, 2007.*
2. *G. P. Srivastava, V. L. Gupta, "Microwave Devices And Circuit Design", Prentice HallIndia Private Limited, First Edition, 2006.*

15ECE349 MICROWAVE SOLID STATE DEVICES 3 0 0 3

(Pre-requisite: 15ECE211 Electronic Circuits)

Unit 1

Introduction to radio frequency transistors and diodes: Transit time effects – Silicon and GaAs material properties – Applications. Bipolar Transistors (BJT): Physical structure – Configuration – Operation – Amplification phenomena. Hetero junction BJT: Operational mechanism – Applications: Tunnel effect: Tunnel diodes and operation.

Unit 2

Field effect transistors (FET): Junction FET: Structure – Operation – I-V characteristics. Metal Semiconductor FET (MESFET): Structure – Operation – Cutoff and maximum oscillation Frequency. High electron mobility Transistors (HEMT): Structure – Operation and electronic applications. Metal oxide semiconductor FET: Maximum operation frequency – CMOS, NMOS Memory devices.

Unit 3

Transferred electron devices: Gunn effect – GaAs diode – Ridley's Watkins Hilsum Theory – Negative resistance – Two valley model theory – High field domain – Modes of operation – Classification of modes – Limited space charge accumulation – LSA diodes – InP diodes. Avalanche transit time devices: Read diodes – IMPATT – TRAPATT – BARITT – Parametric devices. Monolithic microwave integrated circuits: Materials – Substrate: conductor, Dielectric – Resistive materials – MMIC fabrication techniques – MOSFET fabrication – Thin film formation – Hybrid integrated circuit fabrication.

TEXTBOOK:

Samuel. Y. Liao, "Microwave Devices and Circuits", Pearson Education, Third Edition, 2004.

REFERENCES:

1. *Matthew. M. Radmanesh, "Radio Frequency and Microwave Electronics Illustrated", Pearson Education, First Edition, 2006.*
2. *R. Ludwig and P. Bretchko, "RF Circuit Design-Theory and Applications", Pearson Education, First Edition, 2006.*

15ECE350 MILLIMETER WAVE PERSONAL COMMUNICATION SYSTEM 3 0 0 3

Unit 1

Indoor propagation modeling: Introduction – Interference - Indoor propagation effects - ITU indoor path loss model - Long distance path loss model - link budget. Millimeter Wave (MMW) characteristics: MMW characteristics - 60 GHz MMW radio:Principle and technology - Channel performance at 60 GHz - Gigabit wireless communications - Development of MMW standards - Coexistence with wireless backhaul.

Unit 2

Review of modulations for MMW communications: PSK - OFDM. MMW transceivers: Transceiver architecture. MMW antennas: Path loss and antenna directivity - Antenna beamwidth – Beamsteering antenna.

Unit 3

MMW MIMO: Spatial diversity of antenna arrays - Multiple antennas - Multiple transceivers - Noise coupling in a MIMO system. Potential benefits of advanced diversity for MMW: Spatial and temporal diversity - Spatial and frequency diversity - Dynamic spatial, Frequency and modulation allocation. Advanced beamsteering and beamforming: The need for beamsteering / beamforming. MMW applications.

TEXTBOOK:

Kao-Cheng Huang, Zhoacheng Wang, "Millimeter Wave Communication Systems", Wiley IEEE press, 2011.

REFERENCES:

1. *John S. Seybold "Introduction to RF propagation,"John Wiley and Sons, 2005.*
2. *Chia-Chin Chong, Kiyoshi Hamaguchi, Peter F. M. Smulders and Su-Khiong, "Millimeter - Wave Wireless Communication Systems: Theory and Applications," Hindawi Publishing Corporation, 2007.*

15ECE351 MIMO AND MULTICARRIER SYSTEMS 3 0 0 3

(Pre-requisite: 15ECE312 Digital Communication)

Unit 1

Introduction - Crowded spectrum - Need for high data rates – Multiple input multiple output systems – Multi antenna systems and concepts - Spatial multiplexing - MIMO system model- MIMO system capacity- Channel known to the transmitter - Channel unknown to the transmitter - Water-pouring principle – Capacity calculation – SIMO - MISO - Ergodic capacity - Outage capacity – Influence of fading Correlation on MIMO capacity - Influence of LOS on MIMO capacity.

Unit 2

Delay diversity scheme- Alamouti space - time code - Maximum likelihood decoding - Maximum ratio combining - Transmit diversity - Space-time block codes - STBC for real signal constellations - Decoding of STBC-OSTBC - Capacity of OSTBC channels - Space-time code Word design criteria – Multiplexing architecture - V-BLAST architecture.

Unit 3

Data transmission over multipath channels - Single carrier approach - Multicarrier approach - OFDM - OFDM generation - Cyclic prefix - Performance of space - Time coding on frequency-Selective fading channels- Capacity of MIMO - OFDM systems - Performance analysis of MIMO-OFDM systems.

TEXTBOOKS:

1. *MohinderJanakiram, "Space time Processing and MIMO systems",Artech House, First Edition, 2004.*
2. *ArogyaswamiPaulraj, RohitNabar, Dhananjay Gore, "Introduction to Space-Time Wireless Communications", Cambridge University Press, 2008.*

REFERENCES:

1. *Hamid Jafarkhani, "Space Time coding-Theory and Practice",Cambridge University Press, First Edition, 2005.*
2. *BrankaVucetic, Jinhong Yuan, "Space Time coding", John Wiley and Sons, First Edition, 2003.*
3. *Andrea Goldsmith, "Wireless Communication", Cambridge University Press, First Edition. 2005.*
4. *David Tse, PramodViswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.*

15ECE352 MULTIMEDIA COMMUNICATION STANDARDS 3 0 0 3

Unit 1

Introduction to multimedia communications - Multimedia representation – Digitizationprinciples – Text - Audio and video content representation. Text and image compression: Introduction - compression principles text compression - Image compression - Audio and Video compression.

Unit 2

Standards of multimedia communication-introduction - reference models - Interpersonal andinteractice standards - Standard entertainment applications. Internet – Introduction - IP diagram – Fragmentationand reassembly – HRP – RAR message format and transmission - Routing algorithm – ICMP - QOS support - PPP link layer protocol - IPv6 - IPv6/IPv4 interoperability.

Unit 3

Broadband ATM networks - Cell format and switching principles - Switch architecture and protocol architectures - ATM's LAN - MAN and WIDE area network.

Entertainment networks and high speed modem: Cable TV network - Satellite TV network and Terrestrial TV network. Internet applications - High speed PSTN access technologies. Internet applications and world wide web.

TEXTBOOK:

Fred Halsall, "Multimedia communications, Applications, Networks, Protocols and Standards" Pearson education, 2009 reprint.

REFERENCES:

1. *Morris Mano, "Introduction to Data Communications and networking", First Edition, Pearson Education, 2006.*
2. *S.Kesav, "An Engineering Approach to Computer Networking: ATM Networks, the Internet, and the Telephone Network", First edition, Pearson education Indian print.*
3. *IEEE Transactions on Multimedia.*
4. *ACM transaction on multimedia computing.*

15ECE353 OPTICAL COMMUNICATION 3 0 0 3

(Pre-requisite: 15ECE301 Communication Theory)

Unit 1

Introduction - Ray theory transmission - Electromagnetic mode theory for optical propagation - Cylindrical fibers - Single-mode fibers – Attenuation - Material absorption losses in silica glass fibers - Linear and nonlinear scattering losses - Fiber bend losses - Chromatic and intermodal dispersion.

Unit 2

Optical detectors: Introduction - Device types - Optical detection principles – Absorption -Quantum efficiency – Responsivity - Long-wavelength cutoff - Semiconductor photodiodes with and without internal gain.

Unit 3

Link design - System degradation and power penalty - Measurements on fiber optic systems – SONET – EDFA - WDM components and networks.

TEXTBOOK:

John M Senior, "Optical Fiber Communication, Principles and Practice", Third Edition, Prentice Hall, 2009.

REFERENCES:

1. *Gerd Keiser, "Optical Fiber Communication", Fourth Edition, MGH, 2008.*
2. *Joseph C. Palais, "Fiber Optic Communications", Fourth Edition, Pearson Education, 2004.*
3. *C. Siva Ram Murthy and Mohan Gurusamy, "WDM Optical Networks: Concepts, Design,andAlgorithms"Prentice-Hall, 2002.*

15ECE354 PRINCIPLES OF RFID DESIGN 3 0 0 3

Unit 1

Introduction to RFID - Comparison with other identification systems - Operating and physical principles. Types of tags - Passive, active, semi-passive, security issues, memory capacity - Radio regulatory issues and frequency ranges. Challenges in deployment-cost comparison of tags and readers in India.

Unit 2

Communication principles, coding, modulation and demodulation - Data integrity multiple access procedures -Anti-collision procedures - Security issues and solutions. Hardware architecture of Tags and readers - Transponder design – memory- Sensors. Reader RF inrerface-control unit – Middleware - Near field communications. Comparison of successful RFID standards.

Unit 3

Case studies - Smart cards - Public transport - Payment systems - NFC Applications - Electronic passport - Ski Tickets - Access control - Online and offline Systems - Supply chain and transport systems - Container transport animal identification - Stock keeping - Industrial and medical applications.

TEXTBOOK:

Klaus Finkenzeller, "RFID Handbook - Fundamentals and applications in contactlesssmart cards, radio frequency identification and near-field communication", 3rd edition,Wiley 2010.

REFERENCES:

1. *Curty, Declercq, Dehollain and Joehl, "Design and Optimization of passive UHF RFID Systems", Springer, 2007.*
2. *V.D. Daniel, A. Puglia and M. Puglia, "RFID: A Guide to Radio Frequency Identification", Wiley, 2007.*

15ECE355 RADIO FREQUENCY CIRCUIT DESIGN 3 0 0 3

(Pre-requisite: 15ECE402 Radio Frequency Engineering)

Unit 1

Radio frequency concepts: Frequency spectrum and applications – Behavior of passive components at radio frequencies – Design parameters. RF Passive components: Transmission lines and equivalent circuits – Design of transmission lines and transmission lines based devices - Smith chart representation.

Unit 2

RF Network theory: Interconnection of networks – Scattering parameters and properties - RF measurements and principles. Active RF components and modeling: Diode – Transistor – measurements of parameters – scattering parameter characterization.

Unit 3

RF System Design: Impedance matching concepts – Microstrip matching – Transistor biasing networks – Amplifier design concepts and power relations – Design of portable systems.

TEXTBOOK:

R. Ludwig and P. Bretchko, "RF Circuit Design-Theory and Applications", Pearson Education, First Edition, 2006.

REFERENCES:

1. *Matthew.M.Radmanesh, "Radio Frequency and Microwave Electronics Illustrated", Pearson Education, First impression, 2006.*
2. *D.M.Pozar, "Microwave Engineering", Wiley India Limited, Third Edition, 2007.*

15ECE356 SATELLITE COMMUNICATION 3 0 0 3

(Pre-requisite: 15ECE301 Communication Theory)

Unit 1

Review of Microwave Communications - Overview of satellite communications - Satellite orbits - Orbital mechanics and effects - Kepler's laws - Configurations of various orbits - Orbital elements - Elevation and azimuth angles - Doppler effect - Effect of the sun and moon - Sun transit outage. Satellite link models and design - Satellite system parameters - Link budget design.

Unit 2

Satellite subsystems – AOCS - TTC&M - Power and communication subsystems - Computations and controlling by processors - Satellite multiple access schemes – FDMA - TDMA and CDMA - Spread spectrum concepts - Comparison of multiple access schemes.

Unit 3

Satellite applications – VSAT - DTH television principles - Direct broadcast radios - Principles of navigation – GPS - Satellites and launch vehicles – INSAT - IRS satellites – PSLVs - GSLVs.

TEXTBOOK:

T.Pratt, C.W.Bostain and J.E.Allnut, "Satellite Communications" John Wiley and Sons, Second Edition, 2003.

REFERENCE:

Dennis Roddy, "Satellite Communications" McGraw-Hill Publishing company, Fourth Edition, 2006.

15ECE357 SOFTWARE DEFINED RADIO 3 0 0 3

(Pre-requisite: 15ECE312 Digital Communication)

Unit 1

Convergence of signal processing and communication engineering - Introduction of Software Defined Radio (SDR) - re configurability - Advantages of SDR over conventional radio –SDR architecture - Implementation. RF Implementation and front ends – Flexible RF system.

Unit 2

Multirate signal processing: Sample rate conversion- principles - Decimation and interpolation – DDC – DUC –Polyphase – filters- CIC filters - Digital filter banks. Timing recovery – Digital generation of signals – Applications of direct digital synthesis.

Unit 3

Parameters of Data converters, ADC and DAC architectures- Digital hardware choices – Case studies - Demonstration of SDR coupled to GNU radio.

TEXTBOOK:

J. H. Reed, "Software Radio A modern approach to Radio Engineering", Prentice Hall 2002.

REFERENCES:

1. *Behrouz. F. Bourjney" Signal Processing for Software defined Radios", Lulu 2008.*
2. *P. B. Kennington "RF and baseband techniques for software defined radio" Artech house 2005.*
3. *P. Bums "Software defined radio for 3G" Artech house, 2003.*
4. *T. J. Rauphal "RF and Digital signal processing for software radios, A multi-standard multimode approach", Elsevier, 2008.*

15ECE358 SPREAD SPECTRUM COMMUNICATION 3 0 0 3

(Pre-requisite: 15ECE312 Digital Communication)

Unit 1

Introduction to spread spectrum - Direct sequence spread spectrum - Spreading sequences and Waveforms: - Pseudo-random sequence generation- Maximal sequences - Autocorrelations and Power spectrums of codes - Characteristic polynomials - Generation of gold codes – Interference rejection for DS/SS. Frequency hopping spread spectrum - Frequency synthesizers - Multitone jamming - Hybrid systems.

Unit 2

Synchronization issues for spread-spectrum - Phase lock loop - Delay lock loop - Acquisition of spreading sequences – Serial search acquisition - Introduction to code tracking.

Unit 3

Detection of spread spectrum signals - Performance of direct sequence spread spectrum - Performance of frequency hopped spread spectrum - Performance of spread spectrum system with forward error correction. Low probability of detection - Code division multiple access (CDMA).

TEXTBOOK:

Don Torrieri "Principles of Spread-Spectrum Communication Systems", Second Edition, Springer New York Dordrecht Heidelberg London.2011.

REFERENCES:

1. *Roger L Peterson, Rodger E Ziemer, David E Borth, "Introduction to Spread Spectrum Communication", Pearson Education, First Edition, 2013.*
2. *John. G Proakis&MasoudSalehi, "Digital Communication", Tata McGraw Hill Publishing Company Limited, Fifth Edition, 2009.*
3. *Rappaport, T. S, "Wireless Communications", Pearson Education Asia,2003.*

15ECE359 WIRELESS COMMUNICATION 3 0 0 3

(Pre-requisite: 15ECE312 Digital Communication)

Unit 1

Introduction to wireless communications - Large scale path loss - Free space propagation model - Two ray model - Practical link budget design – Outdoor and indoor propagation models. Small scale multi path propagation - Impulse response model of a multi path channel - Parameters of mobile multi path channels - Types of small scale fading.

Unit 2

Rayleigh and Rician distributions – Statistical models for multipath fading channels – Theory of multipath shaping factors - Equalization - Linear - Decision feedback - Adaptive equalizers - Training and tracking. Diversity – Receiver diversity – Transmitter diversity.

Unit 3

Capacity of wireless channels – Capacity in AWGN – Flat fading channels – Frequency selective channels – Time invariant and variant channels - Performance of digital modulations over wireless channels – AWGN and Fading channels.

TEXTBOOKS:

1. *Andrea Goldmith, "Wireless Communication", Cambridge University Press, 2005.*
2. *T.S. Rappaport, "Wireless Communication, Principles and Practice", Pearson Education, Second Edition, 2002.*

REFERENCES:

1. *William C Y Lee, "Wireless and Cellular Communications", Tata McGraw Hill Publishing Company Limited, Third Edition, 2006.*
2. *KamiloFeher, "Wireless Digital Communications", Prentice Hall India Private Limited, 2004.*

15ECE363 DATA SECURITY 3 0 0 3

Unit 1

Introduction:History of Cryptography. Mathematical background: Probability theory -Information theory - Complexity theory, Number theory. Symmetric (Private) Key Cryptographic Systems: Caesar – Affine - Monoalphabetic Substitution – Transposition - Homophonic substitution – Vignere - Beauford and DES Family - Product ciphers - Lucifer and DES.

Unit 2

Asymmetric (Public) Key Cryptographic Systems: Concept of PKCS, RSA Cryptosystem- Variants of RSA - Primality testing - Security of RSA - Merkle – Hellamn - Security of Merkle – Hellaman, ElGamal. Elliptical Curve Cryptography. Stream ciphers and block ciphers: The one time pad - Synchronous stream ciphers - Self-synchronizing stream ciphers - Feedback shift registers - Linear Complexity – Non-linear feedback shift registers - Stream ciphers based LFSRs. Non-linear Combination generators - Non linear filter generators - Clock controlled generators - The alternating step generators - The shrinking generators.

Unit 3

Digital Signatures: Properties, Generic signature schemes - Rabin Lamport - Matyas-meyer, RSA - Multiple RSA and ElGamal Signatures - Digital signature standard - Blind Signatures- RSA Blind. Secret Sharing Algorithms: Threshold secret sharing - Shamir scheme, Blakley scheme and modular Scheme. Pseudo random number generators: Definition of randomness and pseudo-randomness - Statistical tests of randomness - Linear congruential generator - Modern PRNGs (a brief description).

TEXTBOOKS:

1. *Padmanabhan T R, Shyamala C and Harini N, "Cryptography and Security", Wiley Publications 2011.*
2. *Josef Pieprzyk, Thomas Hardjono and Jenifer Seberry, "Fundamentals of Computer Security", Springer 2010.*

REFERENCES:

1. *Douglas R Stinson, "Cryptography:Theory and Practice", CRC Press 2005.*
2. *Alfred J Menezes, Paul C Van Oorshot and Scott A. Vanstone, "Handbook of Applied Cryptography", CRC press 1996.*

15ECE364 DIGITAL IC DESIGN 3 0 0 3

(Pre-requisite: 15ECE202 Digital Circuits and Systems)

Unit 1

Fast Adders: Hybrid adders, Carry save adder, Kogge-stone and Brent-Kugg adders. Multiplier: Booth, Booth recoded and Wallace tree implementation; Data Representation: Decimal representation – Alphanumeric representation – Fixed point representation – Floating point representation; Fixed point Arithmetic: Hardware implementation and hardware algorithm for fixed point Addition – subtraction, Multiplication and division with signed magnitude data; Floating point arithmetic: Hardware implementation and hardware algorithm for floating point addition – subtraction, multiplication and division with signed magnitude data.

Unit 2

BDD: Binary decision diagram, ordered BDD; Hazards: Static hazard detection and elimination, LPDD; Timing Analysis: Definitions of Set-up, hold time, skew, jitter. Critical path delay analysis; Design of Network application: ATM switch Design, ATM packet generator and decoder. Mapping Algorithms; mixed logic and entered variable K-Map.

Unit 3

Asynchronous state machines: Fundamentals – Mode Model – Problem of Asynchronous circuit design – Asynchronous design examples; Programmable Logic Devices: PLD's - FPGA's – LUT, CLB - FPGA Design Flow - Xilinx Spartan &Virtex Family Devices; Fault Detection & Location: Boolean difference method and path sensitization method in combinational circuits.

TEXTBOOKS:

1. *M. Rafiquzzaman, "Digital Logic and Microcomputer Design", John Wiley & Sons Inc., Fifth edition, 2005.*
2. *Richard F. Tinder, "Engineering Digital Design", Academic Press, Second edition, 2000.*

REFERENCES:

1. *Morris Mano, "Digital Design", Pearson Education, Third Edition, 2002.*
2. *A. P. Godse and D. A. Godse, "Digital Electronics and Logic Design", Technical Publications, First Edition, 2009.*

15ECE365 ELECTRONIC SYSTEM LEVEL DESIGN AND VERIFICATION 3 0 0 3

(Pre-requisite: 15ECE313 VLSI Design)

Unit 1

Electronic system level design: Languages (C++, Verilog and SystemC) - Flows and methodologies – Architecture exploration, Models for system level design and functional Simulation,

Unit 2

Electronic system level verification: Verification languages (Verilog and System Verilog) - Verification flows and methodologies (UVM) - HW-SW co-verification.

Unit 3

Open source tools – Bluespec and Accellera, case study.

TEXTBOOKS:

1. *Michael D. Ciletti, "Advance Digital Design with Verilog HDL", Pearson Higher Education, 2011.*
2. *Chris Spear and Greg Tumbush, "System Verilog for Verification: A Guide to Learning the Testbench Language Features" Third Edition, Springer, 2012.*

REFERENCES:

1. *Sandro Rigo, Rodolfo Azevedo and Luiz Santos, "Electronic System Level Design – An Open-Source Approach", Springer, 2011.*
2. *Brian Bailey and Grant Martin, "ESL Models and their Application for Electronic System Level Design and Verification in Practice", Springer, 2010.*
3. *David Black, Jack Donovan, Bill Bunton and Anna Keist, "System C from the ground up", Second Edition, Springer, 2010.*

15ECE366 EMBEDDED SYSTEMS 3 0 0 3

(Pre-requisite: 15ECE304 Microprocessor and Microcontroller)

Unit 1

Introduction to Embedded Systems: Introduction to embedded systems – Application areas – Compiling - Linking and locating – Downloading and debugging. Embedded processor architecture definitions: SIMD – MIMD – SISD – MISD – VLIW – Superscalar – Pipelining - RISC – CISC. DSP processor architecture: Modified harvard architecture - Barrel shifters – Multipliers - MAC unit - Manufacturers of DSP processors.

Unit 2

Real time operating system concepts: Tasks - Task states – Context switching - Message box - Message queue - Semaphores – Binary counting and mutex semaphores – Deadlock - Priority Inversion. Scheduling algorithms: Round robin - Rate monotonic - Earliest deadline first.

Unit 3

ARM cortex M3 processor: ARM processor - ARM cortex M3 architecture - NXP LPC214x On chip Peripherals: A/D converters, PWM, Timer/Counter, UART and its Interfacing- Application development using Keil IDE.

TEXTBOOKS:

1. *David E.Simon, "AnEmbedded Software Primer", Pearson Education, 2006.*
2. *Steve Furber, "ARM system On Chip Architecture", Addison Wesley, 2000.*

REFERENCES:

1. *Joseph Yiu, "The Definitive Guide to the ARM Cortex M3", Second Edition, Elsevier Inc., 2010.*
2. *Jean J. Labrosse, "Micro /OS-II, The real time kernel", Second Edition, CMP books1998.*
3. *Arnold S. Berger, "Embedded System Design", CMP Books, USA 2002.*
4. *Michael Barr, "Programming Embedded Systems with C and GNU", O Reilly, 2003.*

15ECE367 HARDWARE SECURITY AND TRUST 3 0 0 3

(Pre-requisite: 15ECE202 Digital Circuits and Systems)

Unit 1

Background on VLSI testing – Test generation - Structured DFT techniques overview – Scan design - Boundary scan method – BIST schemes - Hardware trojan – Trojan taxonomy - Case study - Trojan detection – Classification of trojan detection - Challenges in trojan detection.

Unit 2

Design for hardware trust – Delay based methods – Shadow registers – Ring oscillators - Dummy scan Flip-Flop insertion - Trojan activation time analysis - Layout-aware scan cell reordering - Trojan detection and isolation flow.

Unit 3

Security and testing – Scan-based testing – Scan-based attacks and counter measures - System-on-chip test infrastructure - Emerging areas of test security. Trojan prevention: Built-in self authentication - BISA structure and insertion flow - Analyzing BISA structure - Trusted design in FPGAs.

TEXTBOOK:

Mohammad Tehranipoor and Cliff Wang (Eds.), "Introduction to Hardware Security and Trust", Springer, New York, 2012.

REFERENCE:

1. *Mohammad Tehranipoor, Hassan Salmani and Xuehui Zhang, "Integrated Circuit Authentication - Hardware Trojans and Counterfeit Detection", Springer International Publishing, Switzerland 2014.*

15ECE368 INTRODUCTION TO SOFT COMPUTING 3 0 0 3

Unit 1

Overview of Artificial Neural Networks (ANN) - Models of a neuron - Network architectures - Bayes theorem - Naïve Bayes classifier - Rosenblatt's Perceptron - Perceptron convergence theorem - Multilayer Perceptrons - Back propagation - Application of ANN in Classification and Regression - Classifier performance measures - Validation techniques.

Unit 2

Fundamentals of Genetic Algorithms - Creation of offspring – Encoding - Fitness function - Reproduction - Inheritance operators – Crossover - Inversion and deletion – Mutation - Generational cycle - Convergence of GA - Applications.

Unit 3

Introduction to basic Particle Swarm Optimization (PSO) algorithm – Swarm size – Information links – Initialization – Equations of motion – Interval confinement – Proximity distributions – Applications.

TEXTBOOKS:

1. *Simon Haykin, "Neural Networks & Learning Machines", PHI Learning Pvt. Ltd - New Delhi, Third Edition, 2010.*
2. *Clerc, Maurice, "Particle swarm optimization", John Wiley & Sons, 2010.*

REFERENCES:

1. *Rajasekaran Pai S, G. A Vijayalakshmi, "Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis And Applications", PHI Learning Pvt. Ltd - New Delhi, First Edition, 2003.*
2. *Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", Third Edition, Morgan Kaufmann Publishers (Elsevier), 2011.*

15ECE369 PRINCIPLES OF VLSI TESTING 3 0 0 3

(Pre-requisite: 15ECE313 VLSI Design)

Unit 1

Introduction - Need for testing - Role of testing - Elementary testing concepts - Fault and fault model – Defects - Errors and faults - Glossary of fault models - Single stuck-at fault - Fault equivalence - Equivalence of single stuck-at faults - Fault collapsing - Fault dominance - Checkpoint theorem.

Unit 2

Logic and fault simulation - Modeling circuits for simulation - Algorithms for true value simulation and fault simulation - Binary Decision Diagrams - Introduction and construction - Reduction rules and algorithms - ROBDDs - Operation on BDDs and its algorithms - Representation of digital circuits.

Unit 3

Combinational circuit test generation - Algebraic algorithms - Boolean difference method - Fault-table method – Path sensitizing method - ENF method - Structural algorithms - D-Algorithm - PODEM – Advanced algorithms - Fault detection - Two level circuit fault detection - Multilevel circuit fault detection. Sequential circuit test generation: Time frame expansion.

TEXTBOOK:

Vishwani D. Agrawal and Michael L. Bushnell, "Essentials of Electronic Testing for Digital Memory and Mixed Signal VLSI Circuit," Springer, 2000.

REFERENCES:

1. *Samuel. C.Lee, "Digital Circuits and Logic Design," Prentice Hall India Ltd., 2000.*
2. *Parag K. Lala, "An Introduction to Logic Circuit Testing," Morgan Claypool Publishers, 2009.*
3. *Parag K. Lala, "Digital Circuit Testing and Testability," Academic Press, 1997.*

15ECE370 RISC PROCESSOR DESIGN USING HDL 3 0 0 3

Unit 1

Fundamental techniques of computer design: RISC and CISC architectures - Computer arithmetic - Comparison of RISC and CISC architectures. Verilog: Introduction and review of basic designs using verilog. MIPS processor: Introduction to MIPS features - MIPS instruction set - Logical design of MIPS data path - Control unit and instruction decoder.

Unit 2

Design of single cycle - Multicycle and pipelined architectures of MIPS. Introduction to superscalar - Super pipelined architectures - Performance evaluation of super scalar processors. Verilog design of a pipelined MIPS processor.

Unit 3

Introduction to memory hierarchy: Cache memory fundamentals - Memory systems for superscalar processors. Static timing analysis: Introduction - Setup and hold time constraints - Processor timing issues - Design examples.

TEXTBOOK / REFERENCES:

1. *V.Carl Hamacher, Zvonko G. Vranesic and Safwat G. Zaky, "Computer Organisation", Fifth edition, McGraw-Hill Inc, 1996.*
2. *Hennessy, John L. and David A. "Pattreson, Computer architecture: a quantitative approach", Elsevier, 2012.*
3. *Bhaskar J and Rakesh Chadha, "Static timing analysis for Nanometer designs", Springer 2009.*
4. *Dandamudi, Sivarama P, "Guide to RISC processor for programmers and engineers", Springer, 2005.*
5. *Hayes, John P, "Introduction to digital logic design, Addison", Wesley Longman publishing co., Inc, 1993.*
6. *Bhasker, Jayaram, "A verilog HDL Primer", Star galaxy publishing, 1999.*

15ECE371 VLSI FABRICATION TECHNOLOGY 3 0 0 3

Unit 1

Brief History of Semiconductor technology, Scaling Trends and Scaling Methodologies, Scaling Challenges, ITRS Roadmap; Starting material, silicon structure and properties,

Czochralski and Float Zone crystal growth, GaAs growth; Silicon oxidation methods and properties, Deal Grove Model, Photolithography – masks, pattern transfer techniques, minimum resolvable feature sizes, UV sources, photoresists.

Unit 2

Diffusion and ion implantation, Types of diffusion, Ficks laws, junction depth, Stopping mechanisms, Gaussian implantation profile, variations to predicted distribution, implantation damage and annealing; Deposition requirements and techniques – Physical and Chemical Vapor deposition, Epitaxial growth techniques; Wet and dry etching techniques, Etch requirements, Chemical Mechanical Polishing;

Unit 3

Interconnect Technology – Copper and Aluminum interconnects, Silicodes, Isolation, CMOS and BJT Process flow; CMOS process for sub-100nm era - dielectrics and gate electrodes, Low K Dielectrics with Cu, Strained silicon, Silicon Germanium, Process Techniques to overcome Short Channel Effects, Nanolithography techniques, SOI Technology, Ultra Shallow Junction. Multiple Gate MOSFETs.

TEXTBOOK:

Peter Van Zant, "Microchip Fabrication: A Practical Guide to Semiconductor Processing", McGraw-Hill Professional, Sixth Edition, 2014.

REFERENCES:

1. *Gary. S. May and S. M. Sze, "Fundamentals of semiconductor fabrication", John Wiley, First Edition, 2003.*
2. *Marc J. Madou, "Fundamentals of Microfabrication and Nanotechnology - Volume II", CRC Press, Third Edition, 2011.*
3. *Stephen Campbell, "Science of Microelectronic Fabrication", Oxford University Press, 2001.*
4. *James D. Plummer, Michael D. Deal, Peter B. Griffin, "Silicon VLSI Technology: Fundamentals, Practice and Modeling", Prentice Hall India Private Limited, 2000.*

15ECE372 VLSI DIGITAL SIGNAL PROCESSING SYSTEMS 3 0 0 3

(Pre-requisites: 15ECE313 VLSI Design;15ECE212 Signal Processing II)

Unit 1

Introduction to Digital Signal Processing Systems – Iteration bound – Pipelining and Parallel Processing – Retiming – Unfolding – Folding.

Unit 2

Systolic Architecture Design – Fast Convolution – Algorithmic Strength Reduction in Filters and Transforms – Pipelined and Parallel Recursive and Adaptive Filters.

Unit 3

Scaling and Round off Noise – Digital Lattice Filter Structures – Bit-Level Arithmetic

Architectures – Redundant Arithmetic – Numerical Strength Reduction – Low-Power Design.

TEXT BOOKS / REFERENCES:

1. *Keshab K. Parhi, "VLSI Digital Signal Processing Systems, Design and Implementation", Wiley, 1999.*
2. *Simon Haykin, "Adaptive Filter Theory", Prentice Hall, Fifth Edition 2013.*

15ECE373 VLSI SYSTEM DESIGN 3 0 0 3

(Pre-requisite: 15ECE313 VLSI Design)

Unit 1

Introduction to verilog HDL: ASIC / FPGA design flow – Advantages of HDL – Overview of digital design with verilog HDL. Hierarchical modeling: Basic concepts – Modules and ports. Overview of different levels of abstractions: Gate level modeling – Dataflow modeling – Behavioral modeling – Switch level modeling.

Unit 2

Logic synthesis with verilog HDL: Impact of logic synthesis – Interpretation of a few verilog constructs – Synthesis design flow – Concepts of verification. Introduction to FPGA fabrics: FPGA architectures – SRAM-based FPGAs – Permanently programmed FPGAs – Circuit design of FPGA fabrics – Architecture of FPGA fabrics – Logic implementation of FPGAs – Physical design for FPGAs.

Unit 3

Architecture and large scale Systems: Behavioral design – Design methodologies – Buses – Platform FPGAs – Multi FPGA systems – Novel architecture – FPGA design cycle using Xilinx ISE webpack.

TEXTBOOKS:

1. *Wayne Wolf, "FPGA-Based System Design", First Edition, Prentice Hall India Private Limited, 2004.*
2. *Samir Palnitkar, "Verilog HDL", First Edition, Prentice Hall India Private Limited, 2003.*

REFERENCES:

2. *Stephen Brown, ZvonkoVranesic, "Fundamentals of Digital Logic with Verilog Design", First Edition, Tata McGraw Hill Publishing Company Limited, 2002.*
3. *Stephen M.Trimberger, "Field-Programmable Gate Array Technology", Springer, 1994.*
4. *Clive Maxfield, "The Design Warrior's Guide to FPGAs", Elsevier, 2000.*

15ECE376 AGENT - BASED MODELING 3 0 0 3

Unit 1

Introduction to Agents – Features - Classification of agents. Multi Agent Systems

(MAS) and properties. Agent communication ontology - Agent communication languages: FIPA-ACL, KIF, KQML. Internal structure of MAS: Shell - Reasoning engine. MAS development methodology: Agent behavior - Agent action. Knowledge diffusion in MAS: Application level, behavior level and evolutionary agent communities.

Unit 2

Data mining techniques for intelligent Agents: Association rule mining – Clustering - Classification and evolutionary algorithms.

Unit 3

Applying data mining to agents - Study of available agent based modeling software. Case studies - Application level, behavior level and evolutionary agent communities.

TEXTBOOK:

A. L. Symeonidis, P. A. Mitkas, "Agent Intelligence through DataMining", Springer, 2005.

REFERENCES:

1. *M. Mohammadian, "Intelligent Agents for Data Mining and Information Retrieval", Idea Group Publishing, 2003.*
2. *D. L. Poole, A. K. Mackworth, "Artificial Intelligence: Foundations of Computational Agents", Cambridge University Press, 2010.*

15ECE377 ECONOMETRICS 3 0 0 3

Unit 1

Review of statistics - Random variables – moments – Distributions – least squares – Hypothesis testing - Hetroskedacity – ACF. Index Models – Mean variance analysis – Estimating beta – Multi-index models – CAPM and multifactor models – Market model – Fama – Macbeth – Event studies – Basic structure of event studies – Normal and abnormal returns – Quantitative events.

Unit 2

Time series analysis - ARMA (p,q) – Var(p) – Non-stationary processes – Predicting asset returns – Random walk – Efficient market hypothesis – Predictor methods – Security and technical analysis – Empirical evidence – Maximum likelihood estimation – Test principles – QMLE. ARCH and GARCH – Non-linear extensions – multivariate GARCH.

Unit 3

Option pricing – BS model – Estimation of volatility of a random walk model – Kernel density estimation and regression – Examples of non-parametric estimation. Risk measures – Symmetric dispersion measures – Down side risk.

TEXTBOOK:

D. C. Porter, D. N. Gujarati, S. Gunasekar, "Basic Econometrics", 5th Edition, McGraw Hill Education (India) Pvt. Ltd., 2011.

REFERENCES:

1. *J. M. Wooldridge "Introductory Econometrics: A modern Approach", Second Edition South western college publishing, Thomson learning. 2003.*
2. *Philip Hans Franses "A concise introduction to Econometrics," Cambridge University Press 2002.*
3. *Paul Soderlid. "Lecture notes in Financial Econometrics", University of St. Gallen, Switzerland 2009.*

15ECE378 FINANCIAL ENGINEERING 3 0 0 3

Unit 1

Cash Flows and Fixed income securities: Investments and markets - Principal and interest - Present and future values of streams - IRR. Fixed income securities - Market value for future cash - Bond value - Bond details – Yields – Convexity – Duration - Immunization. Bond portfolio management - Level of market interest rates, Term structure of interest-rate theories.

Unit 2

Stocks and Derivatives: Common stock valuation - Present value of cash dividends - Earnings approach - Value versus price - Efficient markets theory - Technical analysis. Analysis of financial statements. Derivatives - futures and options - Black Scholes formula - Utility functions - Applications in financial decision making.

Unit 3

Portfolio analysis and capital market theory: Covariance of returns – Correlation - Portfolio return - Portfolio standard deviation - Two asset case - Efficient frontier - Optimum portfolio. Capital market theory- Capital market line - Sample diversifications to reduce risk - Characteristic line - Capital asset pricing model. Arbitrage price theory - Stock performance evaluation.

TEXTBOOKS:

1. *David Luenberger, "Investment Science", Oxford University Press, 1998.*
2. *Jack Clark Francis, Richard W. Taylor, "Investments", Schaum's Outlines, Tata McGraw Hill, 2006.*

REFERENCES:

1. *Yuh – DauhLyuu, "Financial Engineering and Computation", Cambridge University Press, 2002.*
2. *Perry H. Beaumont, "Financial Engineering Principles", John Wiley and Sons Inc, New Jersey, 2004.*

15ECE379 SIGNAL PROCESSING FOR BUSINESS APPLICATIONS 3 0 0 3

Unit 1

Introduction - Fourier Vs Wavelets - Seasonality filtering - Signal denoising - Identification of structural breaks – Scaling - Aggregate heterogeneity and time scales - Multiscale Cross Correlation. Review of linear filters – The EWMA and volatility estimation - The Hodrick – Prescott filter - Baxter – King filter - Filters in technical analysis of financial markets. Optimum linear estimation - Weiner filer - Recursive filtering and Kalman filter - Prediction with Kalmanfilter - Vector Kalman filter estimation - Applications.

Unit 2

Discrete Wavelet transforms – properties - DWT filters - The maximal overlap DWT - Multi resolution analysis – ANOVA - practical issues - Filtering FX intraday seasonalities - Causality and co-integration in economics - Money growth and inflation - Long memory processes -Fractional difference processes (FDP) - The DWT of FDP - Simulation of FDP - OLS estimation of FDP - Approximate Maximum likelihood estimation of FDP - Application to stock prices - Generalization of DWT and MODWT - Applications to money supply - Wavelets and seasonal long memory – Applications to money supply – GNP - Seasonality and trends - Unemployment - Consumer price index - Tourism revenues.

Unit 3

Market modes - Moving averages - Momentum functions - Hilbert transforms - Measuring cycle periods - Signal to noise ratio - Sine wave indicator - Instantaneous trend line - Identifying market modes - Designing profitable trading system - Transform arithmetic - FIR, IIR, Removing lag - Adaptive moving averages - Ehlers filters - Measuring market spectra - optimum predictive filters - Adapting standard indicators.

TEXTBOOKS:

1. *Ramazan Gencay, FarukSelcuk& Brandon Whitdly "An Introduction to Wavelets and other filtering methods in Finance and Economics," Academic Press 2002.*
2. *John F Ehlers "Rocket Science for Traders: Digital Signal Processing Applications", John Wiley 2001.*

REFERENCE:

Jack Clark Francis, Richard W. Taylor, "Investments", Schaum's Outlines, Tata McGraw Hill, 2006

15ECE380 TELECOMMUNICATION MANAGEMENT 3 0 0 3

Unit 1

Telecom Technology Fundamentals: Signal transmission and channels – Network media – Data compression – Protocols and topology – Connectivity in networks –

Ethernet principles – Wireless communication principles – Broadcasting versus link - TCP/IP model – OSI model Telecom network management: LAN – WAN – Repeaters – Bridges – Routers – Gateways – Hubs. Electronic commerce: Internet and intranet – Role of government in data communication quality of service in telecommunication. Telecommunication Standards and Regulations: International telecommunication union (ITU) and its role – Frequency management – Cost computations – Mobile and DTH operations – Role of wireless planning commission (WPC) for telecommunications in India - Service providers.

Unit 2

Telecom business management: Automated teller machines – Teleconferencing – Telecommuting – Enterprise applications – Customer oriented communication aspects – Wireless LAN - Telecom billing - Revenue assurance & fraud management. Business on bandwidth: Concepts of data rate and bandwidth requirements – Digital subscriber line – Broadband technologies – Digital home – Telecommuting – Voice enabled DSL - Bandwidth brokerage.

Unit 3

Telecommunication project management: Telecommunication design and implementation – Network analysis and design – Sources of projects – Methodology for designing, developing and implementing telecommunication capabilities – Network modeling – Phases of project management.

TEXTBOOK:

Houston H.Carr and Charles A. Snyder, "The Management of Telecommunications" McGraw-Hill companies Inc, Second Edition, 2003.

REFERENCES:

1. *Willium C.Y. Lee, "Wireless & Cellular Telecommunications", McGraw-Hill Companies Inc, Third Edition, 2006.*
2. *T. S. Rappaport, "Wireless Communication, Principles and Practice", Pearson Education, Second Edition, 2002.*

15ECE381 CIRCUITS AND COMMUNICATION LAB. 0 0 2 1

Electronic circuits

1. Current mirror
2. Amplifier using current biasing
3. Op-Amp characterization
4. Inverting and Non-inverting Amplifier
5. Integrator, Differentiators
6. Schmitt trigger
7. Astablemultivibrator using 555 Timer

Communication

1. Standard Amplitude Modulation and Demodulation
2. Generation of Double Side Band – Suppressed Carrier using Balanced Ring Modulator
3. Synchronous Detector
4. Generation of Single Side Band wave
5. Transistor Mixer
6. Intermediate Frequency Amplifier
7. Frequency Modulation
8. Pre-emphasis and De-emphasis

15ECE382 MICROCONTROLLER LAB. 0 0 2 1

1. ARM Assembly program for Arithmetic and Logical Operations
2. ARM Assembly program for Multi-byte Operations
3. ARM Assembly program for Control Manipulation
4. ARM Assembly program for String Manipulation
5. ARM Assembly program for Thumb Instructions
6. Embedded C Programming using Keil Simulator

a. Simple C Programs
b. Port Programming
c. Peripheral Interfacing – Keypad, Motor, LED etc.

15ECE383 LINEAR INTEGRATED CIRCUITS LAB. 0 0 2 1

1. Current mirror
2. Amplifier using current biasing
3. Op-Amp characterization
4. Inverting and Non-inverting Amplifier
5. Integrator, Differentiators
6. Schmitt trigger
7. Astable multivibrator using 555 Timer

15ECE385 DIGITAL COMMUNICATION LAB. 0 0 2 1

1. Pulse Amplitude Modulation and Demodulation
2. Pulse Position Modulation
3. Pulse Width Modulation
4. Amplitude Shift Keying Modulation and Demodulation
5. Frequency Shift Keying
6. Phase Shift Keying
7. Time Division Multiplexing.
8. Sampling and Quantization Using Matlab.

9. Gram Schmidt orthogonalization for vectors Using Matlab
10. Probability of Error for BPSK using Matlab.

15ECE386 VLSI DESIGN LAB. 0 0 2 1

1. Transfer and Output Characteristics of PMOS and NMOS: Measurement of Threshold voltage, ß,?, and ?.
2. Pass transistor and transmission logic based AND and OR gates: checking “strong” and “weak” ones and zeros.
3. Inverter output response for a given input: Measurement of rise time, fall time, propagation delay, short circuit power and switching power for zero load and a finite capacitance load.
4. Voltage transfer characteristics (VTC) of Inverter: Measurement of mid-point voltage (switching threshold) and noise margin.
5. Realization of CMOS NAND and NOR gates: VTC characteristics and measurement of switching thresholds.
6. Realization of Boolean function: sizing for equal rise time and fall time.
7. Mirror logic based XOR and XNOR gates.
8. Pseudo NMOS based Boolean expression realization: Checking the output swing, input capacitance and short circuit power.
9. Dynamic and Domino logic based Boolean expression realization: Checking charge sharing and monotonicity.
10. Transistor level realization of D Flip-flop with set and reset.

15ECE387 OPEN LAB. 0 1 2 2

The objective of this lab.course is to provide opportunities for hands-on experience in the hardware domain to design, develop and realize prototype electronic systems.

15ECE390 / 15ECE490 LIVE-IN-LAB. 3 cr

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or rural sites during the vacations (after fourth semester or sixth semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth or seventh semester. The objectives and projected outcome of the project should be reviewed and approved by the Dept. chairperson and a faculty assigned as the project guide. On completion of the project, the student shall submit a detailed project report. The report shall be evaluated and the students shall appear for a viva-voce test on the project.

15ECE401 INFORMATION THEORY AND CODING TECHNIQUES 3 1 0 4

(Pre-requisite: 15ECE301 Communication Theory)

Unit 1

Introduction to Information Theory: Modeling of information sources - source coding theorem - source coding algorithms - modeling of communication channels - channel capacity - bounds on communication.

Unit 2

Linear block codes: structure - matrix description - Hamming codes. Standard array arithmetic of Galois fields: Integer ring - finite fields based on integer ring - polynomial rings - finite fields based on polynomial rings - primitive elements. structure of finite fields cyclic codes: Structure of cyclic codes - encoding and decoding of cyclic codes.

Unit 3

BCH codes: Generator polynomials in terms of minimal polynomial - Decoding of BCH codes - Reed-Solomon codes - Peterson-Gorenstein - Zierler decoder. Convolutional Codes: Introduction to Convolutional Codes - Basics of Convolutional Code encoding and decoding - Sequential decoding - Viterbi decoding.

TEXTBOOKS:

1. *Ranjan Bose, “Information Theory, Coding and Cryptography”, Tata McGraw-Hill, Second Edition, 2002.*
2. *P. S. Satyanarayana, "Concepts of Information Theory and Coding", Dynaram Publication, 2005.*

REFERENCES:

1. *Richard B. Wells, “Applied Coding and Information Theory for Engineers”, Pearson Education, LPE, First Indian Reprint, 2004.*
2. *Richard E. Blahut, “Algebraic Codes for Data Transmission”, Cambridge University Press, 2003.*
3. *Shu Lin and Daniel J.Costello, “Error Control Coding – Fundamentals and Applications”, Second Edition, 2004.*
4. *Thomas M Cover and Joy A Thomas, "Elements of Information Theory" MGH 2006.*

15ECE402 RADIO FREQUENCY ENGINEERING 3 1 0 4

(Pre-requisite: 15ECE201 Applied Electromagnetics)

Unit 1

Radio Frequency network Analysis: EM Spectrum and Applications – Electrical Length - Physical Length – Significance of Microwave Spectrum – Applications – Scattering Matrix Parameters and Properties - Insertion Loss, Return loss – Transmission matrix (ABCD) – Signal Flow Graph.

Unit 2

Waveguide Based Devices: Rectangular Waveguide Cavity – Cavity Resonator - Resonant Frequency and Quality Factor – Directional Coupler – Power Dividers and Tee's – Introduction to Ferrites – Ferrite based Isolator and Circulator.

Unit 3

Radio Frequency Systems: Noise in RF Systems – Dynamic Range – Noise Equivalent Temperature – Noise Figure – Noise Figure of Cascaded System – Antenna Parameters – gain – Directivity – Efficiency – Bandwidth – Beam width – Polarization – Dipole - Loops – Horn – Parabolic Dish – Friis Formula - Radio links.

TEXTBOOK:

David M Pozar,"Microwave Engineering", Wiley India Pvt. Limited, Third Edition, Second Reprint, 2007.

REFERENCES:

1. *Samuel Y. Liao, "Microwave Devices and Circuits", Pearson Edition, Third Edition, 2003.*
2. *Kraus, Fleisch, "Electromagnetics with Applications", Tata McGraw Hill Education Private Limited, Fifth Edition, 2004.*

15ECE481 MICROWAVE ENGINEERING LAB. 0 0 2 1

Experiments using Klystron, Gunn diode oscillators and study of various microwave components.

Antennas: Measurement and analysis of RF antennas.

15ECE495 PROJECT PHASE I 2 cr

- Design development and realization of selected problems and solutions based on ECE domain.
- Review and analysis of state of the arttechnology based research and development.
- Publication oriented academic research.
- Industry oriented problems and its solutions.
- Demonstration of working prototype model.
- Preparation of project report in prescribed format.

15ECE499 PROJECT PHASE II 10 cr

- Design development and realization of selected problems and solutions based on ECE domain.
- Review and analysis of state of the arttechnology based research and development.
- Publication oriented academic research.
- Industry oriented problems and its solutions.
- Demonstration of working prototype model.

15EEE111 FUNDAMENTALS OF ELECTRICAL AND ELECTRONICS ENGINEERING 4 0 0 4

Unit 1

Introduction to Electrical Power System; Ideal Independent Current and Voltage Sources, Reference Directions and Symbols; Resistance, Inductance and Capacitance; Ohm's law, Kirchhoff's law, Energy and Power - Series parallel combination of R, L and C Components, DC Series-Parallel Circuits - Voltage Divider and Current Divider Rules - Superposition Theorem, Network Analysis - Mesh and Node methods - Generation of sinusoidal voltage; Instantaneous, Average and effective values of periodic functions; Phasor representation.

Unit 2

Reactance and Impedance; Response in RLC circuits to sinusoidal voltage; Real and Reactive Power, Power factor; Complex Power and Power Triangle - Introduction to Three Phase Systems; Balanced 3-Phase STAR and DELTA connections of Load, Three phase power - Measuring Instruments for AC and DC quantities; Instruments to measure Voltage, Current, Power and Energy - Electromagnetic Induction; Magnetic Circuit Elements; Self and Mutual Inductances - Classification and Applications of Electrical Machines; Torque, Output Power and Efficiency. 3-Phase Induction Motor - Principle of operation, Slip, Torque-speed relation; Single Phase and Three Phase Transformers - Principle of Operation, turns ratio and Connections.

Unit 3

PN junction diode characteristics: unbiased diodes, forward and reverse bias – breakdown – barrier potential – diode approximation - Rectifiers: half wave and full wave - Zener diode – design of regulators and Characteristics - Introduction to BJT: characteristics curves and region of operation; Biasing: Load line – fixed and voltage divider bias - JFET characteristics – 555 Timer – transconductance - Introduction to Operational amplifier: inverting and non-inverting amplifier.

TEXTBOOK:

1. *Edward Hughes, 'Electrical Technology' Seventh edition, Pearson Education Asia, 2011*
2. *A. P. Malvino, Electronic Principles, 7th Edition, Tata McGraw Hill, 2007*

REFERENCES:

1. *S K Bhattcharya, " Basic Electrical and Electronics Engineering", Pearson, 2012*
2. *Vincent Del Toro, 'Electrical Engineering Fundamentals', Second Edition, Prentice Hall of India Private Limited, 2003*
3. *David A Bell, "Electronic Devices and Circuits", Fifth Edition, Oxford University Press 2008*
4. *Michael Tooley B A, "Electronic Circuits: Fundamentals and Applications", Third Edition, Elsevier Ltd, 2006*

15EEE180 WORKSHOP B 0 0 2 1

Part A - Electronics

Identification of electronic components (Passive and Active)

Study of measuring instruments (Voltmeter, Ammeter and Multimeter)

Measurement and theoretical Verification of series and parallel combination of resistors and capacitors

Calibration of CRO and measurements of signal parameters (RMS, maximum value, peak value, time and frequency)

Calibration of function generator using CRO

Soldering practice

Part B - Electrical

1. Study on power supply and protective devices
2. Study on tools and electrical accessories
3. Study on sources of light
4. Study on energy efficiency
5. Study on water pump
6. Study on house hold appliances:
   a. Iron box
   b. Fan
   c. Refrigerator
   d. Air conditioner
7. House wiring I – Glow an incandescent lamp using SPST switch
8. House wiring II – Glow a fluorescent lamp using SPST switch
9. House wiring III – Operate a fan and an incandescent lamp using two independent SPST switch
10. House wiring IV – Operate a fluorescent lamp and a 3 pin socket using two independent SPST switch
11. House wiring V – Staircase wiring
12. House wiring VI – Godown wiring

15EEE201 ANALOG ELECTRONIC CIRCUITS 3 1 0 4

Unit 1

BJT: Current – Voltage characteristics, BJT as an amplifier and as a switch, brief idea of dc analysis, Biasing circuits, small signal operation and models, single stage BJT amplifiers, BJT internal capacitances and high frequency model - Frequency response of CE amplifier. Emitter follower, Darlington-pair.Applications of Diodes: Design of Clipper, clamper circuits and Voltage doubler.

Unit 2

MOS Field Effect Transistors: Introduction, device structures and physical

operations, i-v characteristics, brief analysis as an amplifier, and as a switch, Biasing, small signal operation and models, single stage MOS Amplifiers, MOSFET capacitances, frequency response of CS amplifiers.

Differential Amplifiers: MOS differential Pair, Small signal operation, frequency response of differential amplifier, Introduction to differential amplifier with active load.

Unit 3

Power amplifier: Analysis and Comparison of power amplifiers in Class A, B, AB, D.

Voltage References and Regulators: Design of linear power supplies, Characteristics of voltage regulators, Analysis of series voltage regulator, Integrated circuit voltage regulators.

Feedback amplifiers, Oscillators - RC, LC and Crystal, Multivibrators - Analysis and Design of Bistable, Monostable, Astable Multivibrators and Schmitt trigger using transistors.

TEXTBOOKS:

1. *Adel S. Sedra, Kenneth C. Smith, "Microelectronic Circuits", Oxford University Press, Fifth Edition, 2005.*
2. *Thomas L. Floyd, David M. Buchla, Electronics Fundamentals: Circuits, Devices & Applications, 8th Edition, Pearson education, 2014*

REFERENCES:

1. *Donald E. Neaman, "Electronic Circuit, Analysis and Design", Tata McGraw Hill Publishing Company Limited, Second Edition, 2006.*
2. *David A. Bell, "Electronic devices and Circuits", 5th Edition, Oxford University Press India, 2008.*

15EEE202 ELECTRIC CIRCUITS 3 1 0 4

Unit 1

Practice of Mesh Current and Node Voltage analysis of circuits with independent and dependent sources.

Network Reduction: Source transformation; Star-Delta transformation.

Network Theorems: Thevenin and Norton's theorems; Superposition theorem, maximum power transfer theorem, Tellegan's theorem, Reciprocity theorem.

Introduction to Graph Theory – Definitions; Incidence matrix, Fundamental tie-set matrix, Fundamental cutest matrix, Formulation of network equations using KCL and KVL.

Unit 2

Transient Analysis: Time domain analysis of first and second order circuits - with DC Excitation - Frequency response of Series and Parallel circuits - Resonance - Q-factor and Bandwidth;

Steady State Analysis of single phase AC circuits: Phasor representation and analysis of circuits applying network theorems; Power factor – power factor correction.

Self and mutual inductance - coupled circuits – dot convention; Laplace representation of circuits; solutions using Laplace transforms.

Unit 3

Three phase Circuits: Three phase systems – balanced and unbalanced - Three phase 3-wire and 4-wire circuits – Star and Delta connected source and loads; Phasor Diagram analysis; Complex power.

Two-Port Networks: z, y, ABCD, abcd, hybrid and inverse hybrid parameters and relationships among different network parameters.

TEXTBOOK:

Alexander C K and Sadiku M N O, "Fundamentals of electric circuits", 5th ed. New York, McGraw Hill, 2013.

REFERENCES:

1. *Nahvi M and Edminister J, Schaum's Outline of Electric Circuits, 5th ed. New York, McGraw Hill, 2011.*
2. *Hayt W, Kemmerly J, and Durbin S, Engineering circuit analysis, 7th ed. Boston, McGraw Hill Higher Education, 2007.*
3. *Van Valkenburg M E, Network Analysis, 3rd ed. New Delhi, Prentice Hall-India, 2011.*

15EEE203 ELECTROMAGNETIC THEORY 3 1 0 4

Unit 1

Vectors and co-ordinate systems: Cartesian, cylindrical and spherical co-ordinate systems- scalar and vector fields.

Electric and Magnetic fields: line, surface and volume integrals - Coulomb's law - Gauss's law - Biot-Savart's law - Ampere's circuital law – applications - boundary conditions for electric and magnetic fields - Lorentz force equation.

Unit 2

Maxwell's equations: gradient, curl and divergence - Maxwell's equation in integral form - Law of conservation of charge - Maxwell's equation in differential form - continuity equation - boundary condition for electromagnetic fields.

Electric potential - Poisson's and Laplace's equations – capacitance - energy stored - magnetic scalar and vector potentials - magnetic circuits – inductance - energy stored-conductance.

Unit 3

Uniform plane waves and sinusoidally varying waves in time domain and in free space – polarization - power flow and Poynting vector - wave parameters - plane waves in material media - skin effect - reflection and transmission of uniform plane waves - normal and oblique incidence in conductor and dielectric interfaces.

TEXTBOOK:

N. Narayana Rao, "Elements of Engineering Electromagnetics", Sixth Edition, Pearson Education, 2006.

REFERENCE:

1. *David K. Cheng, "Field and Wave Electromagnetics", Second Edition, Pearson Education, 2002.*
2. *William H. Hayt, John A. Buck, "Engineering Electromagnetics", Seventh Edition, Tata McGraw Hill Publishing Company Limited, 2007.*
3. *Sadiku, "Elements of Electromagnetics", Second Edition, Oxford University Press, 2014.*

15EEE205 ELECTRICAL AND ELECTRONICS ENGINEERING 3 0 2 4

Unit 1

Electrical Engineering

Introduction to Electrical Power System - different sources of electrical energy (conventional / alternate), Ideal Independent Current and Voltage Sources.

Reference Directions and Symbols; Resistance, Inductance and Capacitance, Series parallel combination of R, L and C Components.

Ohm's law, Kirchhoff's law, Energy and Power, Voltage Divider and Current Divider Rules, Network Analysis by Mesh Currents, Nodal analysis.

Faraday's law of Electromagnetic Induction; Magnetic Circuit Elements; Analysis of magnetic Circuits, Self and Mutual Inductances.

Generation of alternating current, Sinusoidal voltage; Instantaneous, Average and rms values of periodic functions; Peak factor, form factor, Phasor representation of sinusoids, Real and Reactive Power, Power factor

Introduction to Three Phase Systems; Balanced 3-Phase STAR and DELTA connections of Load, Three phase power

Unit 2

Classification and Applications of Electrical Machines

DC Motor, Basic principle of operation, Different types of DC motors, Voltage

equation of a motor, significance of back emf, Speed, Torque, Torque-Speed characteristics, Output Power, Efficiency.

3-Phase Induction Motor - Introduction: Principle of operation, rotating magnetic field, types of I.M, Slip, Rotor Speed, Torque-Slip Relation.

Single Phase Transformer - Principle of Operation, Voltage transformation ratio, emf equation, working of single phase auto-transformer, Three Phase Transformer Connections, Star-delta, star-star.

Unit 3

Electronics Engineering

Introduction to semiconductors and doping: Intrinsic and extrinsic semiconductors, PN junction diode characteristics: forward and reverse bias – breakdown – barrier potential Rectifiers: half wave and full wave, Zener diode – design of regulators and Characteristics.

Introduction to BJT: BJT characteristics curves and region of operation, common emitter, common base configurations, MOSFET characteristics.

Introduction to Operational amplifier: inverting and non-inverting amplifier.

Introduction to logic gates: Boolean Algebra Theorems, De Morgan's theorem. Logic gates, NOT Gate, AND Gate, OR Gate, XOR Gate, NAND Gate, NOR Gate, X-NOR Gate.

Microcontrollers: Introduction to Microcontrollers, 8051, Microcontroller, Architecture and an example of Microcontroller, based stepper motor control system (only Block Diagram approach).

TEXTBOOKS:

1. *Edward Hughes - 'Electrical Technology' - Pearson Education Asia - 7th Edition, - 2011*
2. *A. P. Malvino - Electronic Principles - Tata McGraw Hill - 7th Edition - 2007*
3. *Stephen Brown and Zvonko Vranesic – 'Digital Logic Design' - Tata McGraw Hill - 2nd Edition*

REFERENCES:

1. *V N Mittle & Arvind Mittle - 'Basic Electrical Engineering' – McGraw Hill - 2nd Edition, 2014*
2. *Vincent Del Toro - 'Electrical Engineering Fundamentals' - Prentice Hall of India Private Limited - 2nd Edition - 2003*
3. *S. K. Bhattcharya - 'Basic Electrical and Electronics Engineering' - Pearson - 2012*
4. *D. P. Kothari & I. J. Nagrath - 'Theory and Problems of Basic Electrical Engineering" - Prentice Hall of India - 2000*
5. *David A Bell – 'Electronic Devices and Circuits' - Oxford University Press - 5th Edition – 2008*

6. *William Gothmann H. - 'Digital Electronics - An Introduction to Theory and Practice', Prentice Hall of India, 1977*

15EEE211 ANALOG INTEGRATED CIRCUITS 3 0 0 3

Unit 1

Operational amplifiers: Equivalent circuit, voltage transfer curve - Open loop Op-amp configurations – Voltage series, Voltage shunt feedback amplifiers configurations, closed loop differential amplifiers for single and differential outputs.

Output Off set voltage, offset null pins. Minimizing output offset voltage due to input bias current and input offset current, Factors affecting off set parameters. CMRR - Open loop and closed loop frequency response of op-amps, Circuit stability, Slew rate and its effects in applications.

Unit 2

Applications of Op Amp: DC & AC amplifiers - Summing, Scaling and Averaging amplifiers - Instrumentation Amplifier - voltage to current converter for floating and grounded loads - Current to voltage converter - Integrator, Differentiator. Voltage comparators – ZCD-Schmitt trigger with voltage limiter - Precision rectifier circuits - Peak detector - Sample and Hold circuit.

Active Filters: Frequency response characteristics of major active filters, first and higher order low pass and high pass filters, all pass filters.

Unit 3

Oscillators and waveform generators: Requirements for oscillations, Op-amp RC oscillators, square wave generators, triangle and saw tooth waveform generators, astable and monostable operations, Voltage controlled oscillators - IC 555 timer, astable and monostable operation.

Circuit board layout techniques: General considerations – PCB mechanical construction – Grounding – Decoupling – Input, output isolation.

TEXTBOOKS:

1. *Ramakant A. Gayakwad, "Op-Amps and Linear integrated circuits", Prentice Hall of India, 4th Edition, 2000.*
2. *Donald E. Neaman, "Electronic Circuit, Analysis and Design", Tata McGraw Hill Publishing Company Limited, Second Edition, 2002.*

REFERENCES:

1. *Adel S. Sedra, Kenneth C. Smith, "Microelectronic Circuits", Oxford University Press, Fifth Edition, 2004.*

2. *Sergio Franco,?Design with operational amplifiers and Analog Integrated circuits?, Tata McGraw Hill 3rd Edition 2002.*
3. *Ron Manchini, "Op-Amps for Everyone", Design Reference-Texas Instruments, August 2002, Available from: http://www.ti.com/lit/an/slod006b/slod006b.pdf*

15EEE212 ELECTRICAL MACHINES I 3 1 0 4

Unit 1

Basics of electric and magnetic circuits, Principles of electromechanical energy conversion, Basic concepts of rotating machines, Dynamic Equation of Electromechanical Systems.

Unit 2

DC Machines: EMF and Torque, Circuit Model, Armature Reaction, Compensating Winding, Commutation, Methods of Excitation, Magnetization Characteristic, Self-excitation, Types – shunt, series, compound generators and Characteristics of DC Generators, Types and Characteristics of DC Motors, Starting of DC Motors, Speed Control of DC Motors, Braking of DC Motors, Efficiency and Testing, Permanent Magnet DC Machine Applications.

Unit 3

Transformer: Construction and Practical Considerations, Transformer on No-Load, Ideal Transformer, Real Transformer and Equivalent Circuit, Transformer Losses, Transformer Testing, Efficiency and Voltage Regulation, Excitation Phenomenon in Transformers, Autotransformers, Three-phase Transformers, star-star, star-delta, zig-zag connection. Methods of cooling, Parallel Operation of Transformers, Three-winding Transformers.

TEXTBOOK:

Kothari D. P. and Nagrath I. J., "Electric Machines", Tata McGraw Hill Publishing Company Limited, New Delhi 2004.

REFERENCES:

1. *M. G. Say, "Performance and Design of Direct Current Machines", CBS publishers, New Delhi, 1993.*
2. *Fitzgerald A. E., Charles Kingsley, Jr. and Stephen D. Umans, "Electric Machinery", Tata McGraw Hill Publishing Company Limited, 2002*
3. *Albert E. Clayton, "The performance and design of direct current machines", Tata McGraw Hill Publishing Company Limited, New Delhi, Third Edition, 1992.*
4. *S. K. Bhattacharya, " Electrical Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi*

15EEE213 ELECTRICAL MEASUREMENTS 3 0 0 3

Unit 1

Qualities of measurements: Introduction, performance characteristics, errors in measurements, types of static error, sources of error, dynamic characteristics, statistical analysis, standards.

DC and AC bridges: Wheatstone bridge, Kelvin's Bridge, inductance and capacitance measurements-Maxwell's bridge, De-sauty's bridge, Schering bridge, Wein bridge and Anderson bridge.

Analog meters: Basic meter movement, taut band, Electrodynamometer type (EDM), Moving Iron Instruments. Measurement of current – ammeter, multirange ammeter, Aryton shunt, extension of ammeter ranges. Measurement of voltage – basic meter as voltmeter, multirange voltmeter, extension of voltmeter range, loading effect, AC voltmeter using half wave and full wave rectifier, average, peak and true RMS voltmeters.

Unit 2

Instrument Transformers: Current Transformer, ratio and phase angle error, potential transformer.
Measurement of Power and Energy: EDM type wattmeter and Power factor meters, energy meter, calibration of meters.

Oscilloscope: Basic principle, CRT features, block diagram of oscilloscope, sampling, storage oscilloscopes, Digital storage oscilloscope, applications of CRO.

Transducers: Electrical transducers, selecting a transducers, resistive transducers, strain gauge, thermistor, RTD, inductive transducers, LVDT, capacitive transducer, piezo electric, photo voltaic cell, photo diode, photo transistors.

Unit 3

Digital Voltmeters: Ramp and dual slope integrating type DVM, Successive approximation type analog to digital conversion techniques, resolution and sensitivity of digital meters, digital frequency, time and phase measurements. Smart energy meter and net metering.

Instrumentation Systems: Block diagram, Signal conditioning systems, Instrumentation amplifier.

Data Acquisition and Data transmission: Objectives of DAS, single/multichannel DAS, digital to analog converters, data loggers, RTU, data transmission systems, advantages of digital transmission, time division multiplexing.

TEXTBOOK:

1. *E. W Golding and F. C Widdis, "Electrical measurements and measuring instruments", The English Language Book society, 1969*
2. *H. S Kalsi, "Electronic Instrumentation", Tata McGraw-Hill Publishing Company Limited, 1995.*

REFERENCE:

1. *A. K. Sawhney, "A Course in Electrical & Electronics Measurements and Instrumentation", Dhanpat Rai and Sons,1984*
2. *Deobeling E. O, "Measurement systems, Applications and Design", Tata McGraw Hill Publishing Company Limited, 2004.*

15EEE281 ELECTRIC CIRCUITS LAB. 0 0 2 1

Familiarization of Electrical measuring Instruments, Verification of network theorems, Series – Parallel circuits, Resonance Circuits, Separation of resistance and reactance, Power factor improvement, Three phase power measurement in balanced and unbalanced circuits. Characteristics of semiconductor devices, half wave and full wave rectifiers.

15EEE282 ELECTRONIC CIRCUITS AND SIMULATION LAB. I 0 0 2 1

Familiarization with simulation software - simulation of circuits using ORCAD.

Experiments on analog electronic circuits - Design and Testing of Common Emitter Amplifier, Differential Amplifier, Common Collector Amplifier, Common Source Amplifier.

15EEE285 ELECTRICAL MACHINES LAB. I 0 0 2 1

DC MACHINES

Performance characteristics, dc shunt, series and compound generators, study of starters, predetermination of efficiency of dc machines, load test, speed control of dc shunt and series motors.

TRANSFORMERS

No load and load test on single phase and three phase transformers, predetermination of efficiency and regulation, three phase transformer connections, phase conversion, parallel operation of transformers.

15EEE286 ELECTRICAL MEASUREMENTS LAB. 0 0 2 1

Electrical Measurements, Calibration of Voltmeter, Ammeter, Wattmeter and Energy Meter. Extension of Instrument range using Instrument transformers. AC and DC bridges, Study of Transducer, application of Transducer.

15EEE287 ELECTRONIC CIRCUITS AND SIMULATION LAB. II 0 0 2 1

Simulation of Electric and Electronics circuits using MATLAB.

Experiments on analog electronic circuits - Schmitt trigger, Linear Voltage Regulator etc.

15EEE301 CONTROL SYSTEMS 3 0 0 3

Unit 1

Introduction to control systems, Mathematical models of physical systems, Block diagram, Signal flow graph, Feedback control system characteristics, reduction of parameter variations, control over system dynamics and disturbance signals, Use of software tools to analyze and design of control system, Performance of feedback control systems.

Unit 2

Test input signals, transient and steady state response of second and higher order systems, Performance indices. Concept of Stability, Routh-Hurwitz Stability criterion, Root locus method, concept, procedure, Frequency response analysis, Bode plots, Polar plots.

Unit 3

Stability in the Frequency domain, Nyquist criterion, Nichol's chart. Introduction to design of feedback systems, Lead-Lag compensation networks, PID controllers, Control system design case studies - Turbine governor, Robotic hand, ship steering.

TEXTBOOK:

Dorf R. C and Bishop R. H, "Modern control systems", Eighth Edition, Addison-Wesley Longman Inc., Indian reprint 1999.

REFERENCES:

1. *Nagrath I J, Gopal M, "Control Systems Engineering", Fifth Edition, New Age Publishers 2004*
2. *Katushiko Ogata "Modern control engineering" Third Edition, Pearson Education, 2004.*
3. *Benjamin C.Kuo "Automatic Control Systems", Sixth Edition, Prentice Hall India Ltd, 2000*

15EEE302 DIGITAL SYSTEMS 3 0 0 3

Unit 1

Introduction to Logic Circuits, Logic Families: Variables and functions, inversion, Truth tables, Logic Gates and Networks, Boolean algebra, Synthesis using AND, OR, NOT, NAND and NOR gates, Design Examples, Introduction to Logic families such as ECL, TTL.

Implementation Technology: Transistor Switches, NMOS Logic Gates, CMOS Logic Gates, Negative Logic System, tri-state logic.

Optimized Implementation of Logic Functions: Karnaugh map, Strategy for minimization, Minimization of Product of sums Forms, Incompletely specified Functions, Multiple – output Circuits, A Tabular Method for minimization.

Number Representation and Arithmetic Circuits: Addition of unsigned Numbers, Signed numbers, Fast Adders.

Unit 2

Combinational Circuit Building Blocks: Multiplexers, Decoders, Encoders, Code Converters, Arithmetic Comparison Circuits.

Flip Flops, Registers, Counters: Basic Latch, Gated SR latch, master slave and edge triggered D flip-flops, T flip-flop, JK flip-flop, registers, counters, reset synchronization, other types of counters, Simple Control for MCB.

Synchronous Sequential Circuits: Basic Design Steps, State Assignment Problem, Mealy state Model, Serial Adders Example, State minimization, Sequential Circuit design for drive control.

Unit 3

Asynchronous Sequential Circuits: Asynchronous Behavior, Analysis of Asynchronous circuits.

TEXTBOOK:

Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital logic with Verilog Design", Tata McGraw Hill Publishing Company Limited, Special Indian Edition, 2007.

REFERENCES:

1. *Morris Mano, "Digital Design", Pearson Education, Third Edition, 2006.*
2. *Donald D Givone, "Digital Principles and Design", Tata McGraw Hill Publishing Company Limited, 2003.*
3. *Allen Dewey, "Analysis and Design of Digital Systems with VHDL", PWS Publishing Company, 1999.*
4. *John F. Wakerly, "Digital Design Principles and Practices", Pearson Education, Third Edition, 2001.*

15EEE303 ELECTRICAL MACHINES II 3 0 0 3

Unit 1

Induction machines - Construction, time and space harmonics, starting and speed control, testing, circle diagram, equivalent circuit, performance curves, torque speed characteristics, slip ring induction motors.

Unit 2

Synchronous machines - construction, generators and motors, salient pole and non-salient pole synchronous machines, characteristics, regulation, parallel operation, operation on infinite Bus, real and reactive power control, power angle curve, stability analysis, Transient and sub transient reactance.

Unit 3

The fractional horse power motors, types, Single phase Induction Motor, construction, starting, Equivalent circuit, performance curves, shaded pole motors, hysteresis motors etc.

TEXTBOOK:

Kothari D. P. and Nagrath I. J., "Electric Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi 2004.

REFERENCES:

1. *M. G. Say, "Performance and Design of Alternating Current Machines", CBS publishers, New Delhi, 1993.*
2. *Fitzgerald A. E., Charles Kingsley, Jr. and Stephen D. Umans, "Electric Machinery", Tata McGraw-Hill Publishing Company Limited, 2002.*
3. *Vincent Del Toro, "Electrical Engineering Fundamentals", Prentice Hall of India Private Ltd, 2002.*
4. *S. K. Bhattacharya, "Electrical Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi.*

15EEE304 SIGNALS AND SYSTEMS 3 0 0 3

Unit 1

Introduction: Integrated approach for continuous and discrete - time cases.

Signals: Classification of signals, Continuous - Discrete time, Even / Odd signals, Periodic/ Non-periodic signals, Deterministic / Random signals, Energy / Power signals, Basic operations on signals, Basic (Continuous / Discrete) signals - unit step, unit impulse, sinusoidal and complex exponential signals etc.

Systems (Continuous / Discrete): Representation, Classification – Linear / Nonlinear, Causal / Noncausal, Time invariant / Time variant, with / without memory, BIBO stability, Feedback system, LTI system – Response of LTI system, Convolution, Properties (Continuous / Discrete), LTI systems – Differential / Difference equation representation and solution, MATLAB exercises for generation of signals.

Unit 2

Fourier analysis of continuous time signals and systems: Fourier series for periodic signals, Fourier transform - Properties of continuous time FT, Frequency response

of continuous time LTI systems, MATLAB exercises for Fourier Series and Fourier Transforms.

Fourier analysis of discrete time signals and systems: Discrete time Fourier series, Discrete Time Fourier transform - Properties of DTFT, Frequency response of discrete time LTI systems, Laplace Transform analysis of systems: ROC, Inverse LT, Unilateral LT, Solving differential equation with initial conditions.

Unit 3

Sampling: Sampling theorem, Reconstruction of signal, Aliasing, Sampling of discrete time signals, Sampling of real time signals from PT, Reconstruction and Analysis of such signals, MATLAB exercises for generation of signals.

z-Transform: Definition, ROC, Inverse z-Transform, Properties, Transform analysis of LTI Systems.

Interrelationship amongst different representation and Transforms.

TEXTBOOK:

Alan V. Oppenheim, Alan S. Willsky, S, Hamid Nawab, "Signals and Systems", Prentice Hall India Private Limited, 1997.

REFERENCES:

1. *Simon Haykin, Barry Van Veen, "Signals and Systems", Second Edition, John Wiley and Sons, 2005.*
2. *Michael J. Roberts, "Fundamentals of Signals and Systems", First Edition, Tata McGraw Hill Publishing Company Limited, 2007.*
3. *Rodger E. Ziemer, William H. Tranter D. Ronald Fannin, "Signals and Systems", Fourth Edition, Pearson Education, 2004.*

15EEE311 DIGITAL SIGNAL PROCESSING 3 0 0 3

Unit 1

Discrete Fourier Transforms: Review of main concepts form Signals and Systems course- Frequency domain sampling and reconstruction of discrete time signals - The DFT as a Linear Transformation - Relationship of the DFT to other Transforms - Properties of DFT - Linear Filtering methods based on DFT - Efficient computation of the DFT-FFT Algorithms. Efficient computation of DFT of Two real sequences - efficient computation of the DFT of a 2N- Point Real sequences - Use of FFT in Linear filtering and correlation.

Unit 2

Digital Filters: Introduction, Specifications of practical filters.

a) FIR Filters: Symmetric and anti-symmetric FIR filters, Design of linear phase FIR filter using Windows / optimization techniques. Design of Linear phase FIR Filters.FIR filters for harmonic elimination.

b) IIR Filters: Design from Analog filters - Design by Approximation of Derivatives, Impulse Invariance and Bilinear Transformation. IIR filters for extraction of fundamental frequency.

c) Characteristics of commonly used Analog filters, Frequency transformations for analog and digital filters.

Unit 3

Digital Filters Realizations: Structures for the realization of Discrete time system - Structures for FIR systems - direct form structures, cascade form structures, frequency sampling structures, Lattice structures. Structures for IIR systems - Direct form structures, Cascade form structures, Parallel form structures and Analysis of Finite Word Length Effect and limit cycle oscillations in recursive systems.

Applications of DSP:
Multirate Digital Signal Processing, Sampling rate conversion, Decimation and interpolation, Introduction to QMFs.
Linear predictive coding, forward linear prediction, Levinson-Durbin algorithm, signal synthesis, Application in power systems

TEXTBOOK:

Sanjit K. Mitra, "Digital Signal Processing, A Practical approach", Tata McGraw Hill Publishing Company Limited, 2005

REFERENCES:

1. *John G Proakis, G. Manolakis, "Digital Signal Processing Principles, Algorithms, Applications", Prentice Hall India Private Limited, Fourth Edition, 2007.*
2. *Allen V. Oppenheim, Ronald W. Schafer, "Discrete time Signal Processing" Prentice Hall India Private Limited, Fifth Edition, 2000.*

15EEE312 ELECTRICAL ENERGY SYSTEMS I 3 0 0 3

Unit 1

Structure of electric power system, General layout of power system, Methods of electric power generation - Grid systems advantages - EHV AC and HVDC transmission - Variable load on power stations - Load curve and load duration curve - Power factor improvement – Tariff-Transmission line parameters - Skin effect and proximity effect - Inductance of single phase and three phase

transmission line single and double circuit lines - symmetrical and unsymmetrical spacing.

Unit 2

Capacitance of three phase transmission line - single and double circuit lines - symmetrical and unsymmetrical spacing - bundled conductors -Performance of transmission lines - Efficiency and regulation - Short, medium and long lines - ABCD constants - Ferranti effect - surge impedance - Real and reactive power flow in transmission lines - shunt and series compensation - corona loss. Cables - Construction and characteristics of single and three core cables - Insulation resistance and capacitance of a single core cable, most economical conductor size -Grading of cables.

Unit 3

Insulators – types - voltage distribution in suspension type insulators - string efficiency - Grading of insulators - Mechanical design of transmission lines - sag and span - supports at same level and different levels - sag template and stringing chart – Substations - types, general layout, Neutral grounding, Distribution systems: comparison of distribution systems – radial and ring – two wire dc, ac single phase and three phase systems – current and voltage calculations in distributors with concentrated and distributed loads.

TEXTBOOK:

Kothari D. P. and Nagrath I. J., "Modern Power System Analysis" Tata McGraw Hill Publishing Company,2003.

REFERENCES:

1. *Wadhwa C L, "Electrical Power System", Wiley Eastern Limited, India, 2007.*
2. *Hadi Saadat, "Power System Analysis" McGraw Hill Publishing Company, 2003.*
3. *B. R. Gupta, "Power System Analysis and Design", Third Edition, S. Chand & Company Ltd., 2004.*
4. *Grigsby. L. L, "Electrical Power Engineering Handbook", IEEE Press, 2001.*

15EEE313 POWER ELECTRONICS 3 0 0 3

Unit 1

Power Semiconductor Switches: Controllable switch waveforms and power loss in clamped inductive switching circuit - Desirable characteristics in a switch - Temperature rise and use of heat-sinks. Structure, operation, steady state and switching characteristics, turning on and off, gate drive, rating and protection for power MOSFETs, IGBTs and Thyristors, Phase controlled converters: Single phase and three phase converters in CCM - Performance parameters – DCM operation - Inverter mode of operation -- Effect of source inductance - Gate triggering circuits - Single phase dual converter. Non-sinusoidal analysis.

Unit 2

Single phase AC switching controllers with R and R-L loads - Thyristor controlled inductor - Three phase applications of switching control. Choppers: Applications. Step-down chopper with R load with L filter - Transient and steady state operations - Average and ripple load currents- Back emf loads - CCM and DCM - Input filter. Step-up chopper: Analysis, with CCM – Effect of frequency on DCM/CCM - Two Quadrant chopper with static changeover. High power factor front end converter.

Unit 3

Inverters: Applications – Half bridge inverter – Full bridge inverter with square wave and single pulse width modulated operations – Sine PWM scheme: Single phase full bridge with unipolar voltage switching, performance parameters, AC and DC side currents - Sinusoidal pulse width modulation for three phase inverters, Expressions for phase to neutral voltages – Current regulated modulation - Rectifier mode of operation of inverters - AC side filters - Schemes to generate triangular carrier and sinusoidal reference - Introduction to Space vector pulse width modulation – Multilevel inverter and UPS.

TEXTBOOKS:

1. *Joseph Vithayathil, "Power Electronics", Tata McGraw Hill, 2010.*
2. *Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics converters applicationsand design" Third edition, John Wiley & Sons, 2006.*

REFERENCES:

1. *Muhammad H. Rashid, "Power electronics – circuits, devices and applications" Third edition,*
2. *L. Umanand, "Power Electronics – Essentials and applications", Wiley India Pvt. Ltd. 2009.*

15EEE314 MICROCONTROLLER AND APPLICATIONS 3 0 0 3

Unit 1 Introduction to Microprocessors

Registers - File registers - Memory Organization - Tristate logic – Buses - Memory Address register – Read/Write operations. ROM, RAM, PROM, EPROM, E2PROM. Introduction to elementary processor – Organization - Data Transfer Unit (DTU)operation - Enhanced Data Transfer Unit (EDTU) – opcode - machine language - assembly language - pipeline and system clock. Architecture of 8085 – Addressing modes - Data transfer, data processing and program flow control instructions - Simple assembly language programs.

Unit 2 Introduction to Microcontrollers

PIC16F877 Architecture - Program and Data memory organization - Special Function Registers - Addressing modes, Instruction set. MPLAB Integrated Development Environment – Introduction to Assembly language and Embedded C programming – Stack – Subroutines - Interrupt structure – Peripherals – Input/Output Ports.

Unit 3 PIC Peripherals

Timers/Counters - Watchdog Timer – Capture/Compare/PWM (CCP) - Analog to Digital Converter(ADC) – EEPROM - Serial Communication – USART - Development of Application Programs and interfacing - LED, LCD, Keyboard, DC and Stepper motor interface. Introduction to 8051 Microcontroller: Architecture – Ports - Timers.

TEXTBOOK:

T. R Padmanabhan, "Introduction to microcontrollers and applications", First Edition, Narosa publishing house private limited, 2007.

REFERENCES:

1. *Martin P. Bates, "Programming 8 bit PIC Microcontrollers in C with Interactive Hardware Simulation", Newnes, 2008.*
2. *PIC Micro Mid-Range MCU Family Reference Manual, Micro Chip Technology Inc.*
3. *Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems Using Assembly and C", Prentice Hall, Second Edition, 2005.*

15EEE330 ADVANCED CONTROL SYSTEMS 3 0 0 3

Unit 1

State Variable Analysis and Design: Introduction, concept of state, state variables and state model, state modeling of linear systems, linearization of state equations. State space representation using physical variables, phase variables & canonical variables.

Unit 2

Derivation of transfer function from state model, diagolization, Eigen values, Eigen vectors, generalized Eigen vectors. Solution of state equation, state transition matrix and its properties, computation using Laplace transformation, power series method, Cayley-Hamilton method, concept of controllability & observability, methods of determining the same.

Unit 3

Pole Placement Techniques: stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement, state regulator design, and design of state observer, Controllers- P, PI, PID. Non-linear systems: Introduction, behavior of non-linear system, common physical non-linearity-saturation, friction, backlash, dead zone, relay, multi-variable non-linearity.

Phase plane method, singular points, stability of nonlinear system, limit cycles, construction of phase trajectories. Liapunov stability criteria.

TEXTBOOK:

Ogata. Modern Control Engineering. Fifth edition, Prentice Hall of India, 2009.

REFERENCES:

1. *Franklin and Powell. Feedback Control of Dynamics Systems. Addison-Wesley.*
2. *Di Stefano. Feedback Control Systems. Schaum's outline Series, McGraw Hill, 1967*
3. *Luenberger. Introduction to Dynamic Systems. Wiley. 1979*
4. *Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Eleventh Edition, Prentice Hall, Pearson Education, 2008.*

15EEE331 ADVANCED MICROCONTROLLERS 3 0 0 3

(Prerequisite: 15EEE314 – Microcontroller and Applications)

Unit 1

dsPIC 30F series: Introduction to 16 bit microcontrollers - dsPIC 30F – CPU, Data memory, Program Memory - Instruction set - Programming in Assembly and C- Interrupt Structure.

Unit 2

Peripherals of dsPIC 30F: I/O Ports, Timers, Input Capture, Output Compare, Motor Control PWM, QEI,10 bit A/D Converter, UART, CAN Unit, Application Development.

Unit 3

MSP430 and peripherals: MSP430f2274 - MSP430X22X2 device pin out, DA Package, Functional Block diagram description, Inputs, Outputs, Timers, ADC. Application Development.

TEXTBOOKS:

1. *dsPIC 30F, Reference Manual, Microchip.*
2. *Chris Nagy, " Embedded System Design using the TI MSP 430 Series", First Edition, Newnes,2003*

REFERENCES:

1. *MSP430f2274, Reference manual, Texas Instruments.*
2. *www.microchip.com*
3. *www.ti.com*

15EEE332 COMMUNICATION ENGINEERING 3 0 0 3

Unit 1

Introduction: Communication, Communication systems - Block diagram description of Analog and Digital Systems; Review of Fourier Representation, Waveform Spectra, Bandwidth; Noise - Sources of Noise and their Manifestations into Communication Systems, Noise Figure, Significance of SNR Considerations in Communication Systems.

Modulation: Necessity, Introduction to Analog and Digital Modulation.

Unit 2

Amplitude Modulation: Theory, Modulation Index, Spectral Representation of modulated Waves, Power and Bandwidth Considerations, Carrier and side bands, Modulation Schemes: DSBFC, Suppressed Carrier, SSB Techniques – Filter Systems, Phase Shift Method, Carrier Reinsertion System, VSB, Applications.

Frequency Modulation: Introduction, Theory of FM and Phase Modulation, Frequency Spectrum of FM wave, Applications.

Pulse Communication: Introduction, PWM, PPM, PCM.

Unit 3

Introduction to Digital Communications: Fundamentals of Data Communication Systems, FSK, PSK and QAM.

Applications in Power Systems: Power line carrier, Elements of carrier channel, transmitter, line traps, carrier communication, carrier relaying, power system communication, telemetry, telecontrol.

TEXTBOOKS:

1. *George Kennedy, Bernard Davis, "Electronic Communication Systems", Fifth Edition, Tata McGraw Hill Publishing Company Limited, 2006.*
2. *Wayne Tomasi, "Electronic Communication Systems, Fundamentals through Advanced", Fourth Edition, Pearson Education, 2002.*
3. *Donald G. Fink, H. Wayne Beaty, "Standard Hand Book for Electrical Engineers" Fourteenth Edition, McGraw Hill Publishing Company Limited, 2001 (For application in Power Systems.)*

REFERENCES:

1. *Simon Haykin, "An Introduction to Analog and Digital Communication", Fourth Edition, John Wiley and Sons, 2003.*
2. *Taub, Schilling, "Principles of Communication Systems", Tata McGraw Hill Publishing Company Limited, 2004.*
3. *Dennis Roddy, John Coolen, "Electronic Communications", Fourth Edition ,Pearson Education, 2004*

15EEE333 DEREGULATED POWER SYSTEM 3 0 0 3

Unit 1

Power Sector in India – Classical Operation of Power System, Least Cost Operation, Marginal Cost, Incremental Cost – inter utility interchange. Fundamentals of deregulated power system: Requirements and key issues – restructuring models – independent system operator (ISO).

Unit 2

Electricity Market: Competitive market - supply and demand functions, market equilibrium, types of market. Market power and mitigation, imperfect market. Transmission open access: transmission pricing, pricing scheme, concept of distribution factors – Location based Marginal Pricing LMPs.

Unit 3

Transmission capacity: Available Transfer Capacity (ATC), Open Access Same-time Information Systems (OASIS) – Transmission congestion management – Ancillary services: classification and definition – Indian Electricity Acts and Policies – 2003 acts – Availability Based Tariff (ABT).

TEXTBOOKS:

1. *Kankar Bhattacharya, Math H J. Bollen and Jaap E. Daalder, "Operation of Restructured Power Systems", Springer, 2001.*
2. *M. Shahidehpour and M. Alomoush, "Restructured Electric Power Systems – Operations, Trading and Volatility", CRC Press, 2001.*
3. *Loi Lei Lai (Ed), "Power System Restructuring and Deregulation: Trading, performance and Information Technology," John Wiley publications, 2001.*

15EEE334 DESIGN OF ELECTRICAL APPARATUS 3 0 0 3

(Prerequisite: 15EEE303 Electrical Machines II)

Unit 1

Introduction: Design factors, Limitations in design, Thermal design aspects, standard specification.

DC machines: Specific loadings, output equation, Design of main dimensions. Design of Armature windings, Design of field system, Design of interpole and commutator.

Transformers: Output equation-volt per turn, main dimensions for three phase and single phase transformers, window dimensions & Yoke design and coil design. Design of tank with tubes.

Unit 2

Induction motor: Specific loadings, output equation, main dimensions, stator design, number of slots, shape and area of slots, rotor design for squirrel cage and slip ring types.

Synchronous machines: Output equation, main dimensions for salient pole and cylindrical rotor alternators, stator design, rotor, pole design for salient pole generators, pole winding calculations, design of cylindrical rotor.

Unit 3

Optimization techniques as applied to design of electrical machines; Study of cooling systems. Computer aided design: Advantage of computer aided design, Flow chart for computer aided design.Standard specifications: Indian standard specifications for copper conductor, power transformers and induction motor. Recent developments in core and insulation materials used in electrical machines;

TEXTBOOK:

A. K. Sawhney and A. Chakarabarti 'A course in Electrical machine Design' Dhanpat Rai & Co., New Delhi, Sixth edition 2006.

REFERENCES:

1. *Alexander Gray "Electrical Machine Design - The Design and Specification of Direct and Alternating Current", Gray Press, 2007.*
2. *Juha Pyrhonen, Tapani Jokinen, Valeria Hrabovcova "Design of Rotating Electrical machines" John Wiley & Son, 2009.*
3. *S. K. Sen, 'Principles of Electrical Machine Design with Computer Programmes', Oxford and IBH Publishing Co. Pvt Ltd., New Delhi, 1987*

15EEE335 DESIGN OF ELECTRICAL SYSTEMS 3 0 0 3

Unit 1

General Introduction, Gathering specific data, Adoption of design - parameters for the particular project, Selection of basic design philosophies, Detailing the electrical System, Preparation of as - erected drawings and design - manuals.

Maximum-demand – MD estimation, Demand factors for HV motors, Calculation of MD on the MCCs, MD, estimation for an entire load-centre substation and MSS, Statutory Inspector's approach to MD estimation.

Unit 2

Sizing of transformer capacity on basis of MD calculations, Consideration and constraints in the sizing of transformers CB ratings, Split bus arrangements, sizing of power-transformer capacity, Sizing of distribution transformer, capacity at ICSS, Techno-economic studies on selection of transformer sizes, sizing the transformer to meet HV motor, starts and voltage dips.

Short-circuit calculations, SC analysis, standards for the SC analysis, Passive and dynamic reactance to be considered for SC analysis, Reactance multipliers for first cycle diagram for SC analysis of 415V system, The computation of AC components of fault currents, Determination of DC component of the fault current and the total fault current, IEC equations, The impact of CB status on fault levels.

Unit 3

Selection of cable sizes, Continuous rating of cables (Standard rating and net-rating), Thermal ampacity of cables, Short time short circuit rating of cables, Mechanical withstand of short circuit forces, Techno economic consideration in selection of cables, SC-withstand capacity of 1.1 kV cable, Voltage drops in 415V motor, feeders and voltage drop based ampacity, The use of copper cables for motors of rating less than 7.5 kW.

TEXTBOOK:

N. Balasubramanian 'Design of Electrical Systems (For Large projects)', Revised edition, The Rukmini studies, Chennai, 1999.

REFERENCES:

1. *TNEB Hand book*
2. *IEEE Hand book*

15EEE336 DIGITAL CONTROL SYSTEMS 3 0 0 3

(Prerequisite: 15EEE301 Control Systems)

Unit 1

Sampled data - Signal reconstruction, Discrete transfer functions, discrete system stability frequency response analysis, models for sampled continuous systems, state space analysis of discrete time systems, errors and non-linearity due to quantization in ADC.

Unit 2

Discrete time sensitivity functions, internal model, principle for digital control, design by pole assignment. System identification, RLS method, minimum variance control, self-tuning methods, dead beat control, state estimation, Luenberger observer,

Unit 3

Kalmann filter DSP based digital control SCADA, Architecture and design, Introduction to control system tool box. Design of state variables feedback systems, controllability and observability.

TEXTBOOK:

M. Gopal, "Digital Control Engineering", Tata McGraw-Hill Publishing Company Limited, 1997.

REFERENCES:

1. *Graham. C. Goodwin et al, "Control system design", Prentice Hall of India, 2001.*
2. *Web resources*
3. *Selected papers from journals*

15EEE337 DIGITAL IMAGE PROCESSING 3 0 0 3

Unit 1

Introduction: Introduction & Applications, Elements of visual perception, Image sensing and acquisition, simple image formation, Image sampling and Quantization, Representing digital pixels, Image quality, Introduction to colour image – RGB and HSI Models.

Image enhancement in Spatial domain: Introduction to image enhancement, basic grey level transforms, Histogram, Histogram-processing equalization, Matching & colour histogram, Enhancement using arithmetic/logic operations, spatial filtering, Smoothing spatial filtering, Sharpening spatial filtering.

Unit 2

Image transform: Fourier transform, SHFT, DFT, FFT, DCT, Hadamard Transform, Wavelets transform (CWT, DWT), KLT, SVD, Applications.

Image Enhancement in frequency domain: Smoothing frequency domain filtering, Sharpening frequency domain filtering, A model for Image degradation / restoration process, Noise model, Mean filtering and filtering, estimating degradation function, inverse filtering, minimum mean square error (wiener filter), Colour image smoothening, sharpening.

Unit 3

Segmentation & Morphological operations: segmentation and threshold function, Different algorithms in thresholding, Line detection, Edge detection, Edge linking by graph search method, Hough transform, Region based segmentation, Matching, colour segmentation, Morphological-dilation and erosion, opening and closing, Hit/ miss transforms, Representation Boundary descriptors, Regional descriptors. Image Compression - need for image compression, Huffman, Run length encoding, shift codes, Vector quantization, Transform coding, JPEG standard, MPEG

TEXTBOOK:

R. C. Gonzalez, R. E. Wood "Digital image processing", Addison-wiley, 2002.

REFERENCES:

1. *K. Jain "Fundamental of digital image processing", Prentice-Hall, 2002.*
2. *R. C. Gonzalez, R. E. Wood "Digital image processing using MATLAB", Pearson Education, 2004*
3. *M. Sonka, V. Hlavac, R. Boyle, "Image processing analysis and machine vision" Chapman & Hall,1998.*

15EEE338 DIGITAL SIGNAL PROCESSORS 3 0 0 3

Unit 1

TMS320C67xx: Basic building blocks of a typical DSP processor – Hardware Multiplier – Barrel Shifter – MAC unit – Modified Harvard architecture - Pipelining. Architecture of TMS320C67xx DSP - Instruction set – Addressing modes.

Unit 2

Blackfin Processor: Blackfin 5xx DSP – Architecture-Instruction set – Addressing modes.

Unit 3

Programming using TMS320C67xx and Blackfin DSPs: Assembly language and C programming – Integrated Development Environment - Code Composer Studio and Visual DSP++ - Application development.

TEXTBOOK:

Rulph Chassaing, "Digital Signal Processing and Applications with the C6713 and C6416 DSK", Wiley-Interscience, 2004

REFERENCES:

1. *Woon Seng Gan and Sen M Kuo, "Embedded Signal Processing with the Micro Signal Architecture", IEEE Computer Society Press, 2008.*
2. *Dahnoun N, "Digital signal processing implementation using the TMS320C6000 DSP platform", Prentice Hall, 2000.*
3. *Andy Bateman, Iain Paterson-Stephens, "The DSP Handbook, Algorithms, Applications and Design Techniques", Prentice-Hall, 2002,*
4. ***www.ti.com and www.analog.com .***

15EEE339 ELECTRICAL SAFETY 3 0 0 3

Unit 1

Introduction – electrostatics – electromagnetism - stored energy - energy radiation and electromagnetic interference – Working principles of electrical equipment – Indian Electricity Act and Rules - statutory requirements from electrical inspectorate – international standards on electrical safety – first aid - cardio pulmonary resuscitation (CPR).

Unit 2

Primary and secondary hazards - Energy leakage - clearances and insulation - voltage classification - heating effects - electrical causes of fire and explosion – ionization - spark and arc-ignition energy – control - Lightning hazards – Fuse – circuit breakers and overload relays – protection against over voltage and under voltage – safe limits of amperage – voltage – safe distance from lines – capacity.

Unit 3

Earth fault protection - earthing standards - FRLS insulation – grounding - equipment grounding earth leakage circuit breaker (ELCB) - Role of environment in selection - safety aspects in application - protection and interlock self-diagnostic features and fail safe concepts - surge withstand capability test requirements - Classification of hazardous zones - intrinsically safe and explosion proof electrical apparatus - increase safe equipment - their selection for different zones - temperature classification - grouping of gases - use of barriers and isolators -equipment certifying agencies.

REFERENCES:

1. *Massimo A. G. Mitolo, "Electrical Safety of Low-Voltage Systems", McGraw-Hill, USA, 2008.*
2. *John Cadick, Mary Capelli-Schellpfeffer, Dennis K. Neitzel, 'Electrical Safety Handbook, McGraw-Hill, New York, USA, 2005.*
3. *Fordham Cooper, W., "Electrical Safety Engineering" Butterworth and Company, London, 1986.*
4. *Palmer Hickman, "Electrical Safety-Related Work Practices", Jones & Bartlett Publishers, London, 2009.*

15EEE340 ELECTROMAGNETIC COMPATIBILITY 3 0 0 3

(Pre-requisite: 15EEE203 Electromagnetic Theory)

Unit 1

Review of electromagnetic principles: Maxwell's equations, plane waves, transmission lines.

Introduction to Finite Element method, Introduction to electromagnetic compatibility, sources of EMI, Transient EMI, Basic definitions of EMC.

Unit 2

EMI Coupling Principles, Conducted, Radiated and Transient Coupling, Common Impedance Ground Coupling, Crosstalk, EMI Control Techniques - Shielding, Grounding, Bonding.

Unit 3

Radiated Common Mode and Ground Loop Coupling, EMI Test Instruments, Various Test Methods and Calibration Procedures, Isolation Transformer, Transient Suppressors, Cable Routing, Signal Control, Component Selection and Mounting Units, EMI Specifications, Civilian & Military Standards.

TEXTBOOK:

C. R. Paul, "Introduction to Electromagnetic Compatibility", John Wiley and Sons, (Wiley Series in Microwave and Optic Engineering), 2006.

REFERENCES:

1. *Henry W Ott, "Electromagnetic Compatibility Engineering", John Wiley, 2009*
2. *Berhard Keiser, "Principles of Electromagnetic Compatibility", Artech House, 3rd Edition,1986*
3. *V. P. Kodali, " Engineering EMC Principles , Measurements and Technologies," IEEE Press,1996*
4. *Rajeev Thottappillil, Course Material on electromagnetic Compatibility, KTH Royal Institute of Technology, Stockholm.*

15EEE341 EMBEDDED SYSTEMS DESIGN 3 0 0 3

(Prerequisite: 15EEE314 Microcontroller and Applications)

Unit 1

Embedded processors: Introduction to Microprocessors – Microcontrollers – Digital Signal Processors - Embedded processors – ARM Cortex M3 Processor - Architecture - ARM Instruction – Addressing modes.

Unit 2

NXP's LPC17xx series Microcontroller: Architecture - Peripherals – Input/Output ports – Timers – ADC – DAC - PWM. Serial Protocols - UART, I2C, CAN, Fire Wire, USB, Parallel Protocols, PCI Bus, ARM Bus, Wireless Protocols, IrDA, Bluetooth, IEEE 802.11. Application development using Keil IDE.

Unit 3

Real time Embedded Systems: Real Time Operating Systems (RTOS) - Task - Task states – Task Management - Scheduler - Intertask Communication and Synchronization – Exceptions and Interrupts – Time management - Memory Management – I/O subsystems. Commercial RTOS - uC/OS-II functions – Porting RTOS on ARM boards.

TEXT / REFERENCES:

1. *Joseph Yiu, "The Definitive Guide to the ARM Cortex-M3", Second Edition, Newnes, 2009.*
2. *Qing Li and Carolyn Yao, "Real-Time Concepts for Embedded Systems", CMP Books, 2003.*
3. *Steve Furber, "ARM System-on-Chip Architecture", Second Edition, Addison Wesley, 2000.*
4. *Jean J. Labrosse, "MicroC/OS – II - The Real Time Kernel", Second Edition, CMP Books, 1998.*
5. *NXP LPC 17xx datasheet. (www.nxp.com)*

15EEE342 FLEXIBLE AC TRANSMISSION SYSTEMS 3 0 0 3

Unit 1

FACTS concept and General system considerations - Transmission Interconnections, Flow of power in an AC system, Loading capability, Power flow and dynamic stability considerations of a transmission interconnection, basic types of FACTS controllers, IEEE definitions, FACTS devices in India and abroad.

Shunt compensation and shunt FACTS devices - Concept of shunt compensation, objectives of shunt compensation, variable impedance type shunt compensators (TCR, TSC, FC-TCR, TSC-TCR) - circuit diagram, principle of operation, working, waveforms / characteristics.

Unit 2

Switched converter type shunt compensator (STATCOM) - circuit diagram, principle of operation, working, waveforms / characteristics, control schemes for shunt compensators.

Series compensation and Series FACTS devices - Concept of series compensation, objectives of series compensation, variable impedance type series compensators (GCSC, TSSC, TCSC), Switching converter type series compensators - circuit diagram, principle of operation, working, waveforms/characteristics, control schemes for series compensators.

Unit 3

Static voltage and phase angle regulators - Objectives of voltage and phase angle regulators, power flow control, improvement of transient stability, power oscillation damping, thyristor-controlled voltage and phase angle regulators.

Combined FACTS compensators and other special purpose FACTS devices - Unified Power flow Controller (UPFC) - objectives and need, principle of operation, Interline power flow controller (IPFC) - objectives and need, principle of operation. NGH - SSR damper, thyristor-controlled braking resistor (TCBR).

Case studies of practical applications of various FACTS devices.

TEXTBOOK:

Narain G. Hingorani and Laszlo Gyugyi, "Understanding FACTS – Concepts and technology of Flexible AC transmission system", IEEE power Engineering Society,1999.

REFERENCES:

1. *T. J. E. Miller, "Reactive power control in Electric systems", Wiley-Interscience Publication, John Wiley and sons, 1982.*
2. *R. Mohan Mathur and Rajiv K. Varma, "Thyristor-based FACTS controller for electrical transmission system, IEEE series on power Engineering", Wiley Interscience, 2002.*
3. *Padiyar K. R, "FACTS controllers in power transmission and distribution", New Age Publishers, India, 2007.*

15EEE343 FUNDAMENTALS OF SOFT COMPUTING 3 0 0 3

Unit 1

Basic concepts: Single layer perception, Multi-Layer Perception, Supervised and

Unsupervised learning, Back propagation networks, Kohnen's Self-organizing networks, Hopfield networks, Distance measures.

Unit 2

Fuzzy Sets: Properties, Membership functions, Fuzzy operations, Applications, Classification and Regression tree, Data Clustering Algorithms, Rule-based Structure identification and Regression trees, neuro fuzzy systems.

Unit 3

Simulated Annealing: Evolutionary Computing, Survival of the Fittest, Fitness Computation, Crossover, Mutation, Reproduction, Rank Method, Rank Space methods, Case Studies on applications of soft computing.

TEXTBOOKS:

1. *Jang. J. S. R, sun. C. T, Mizutani. E, "Neuro fuzzy and Soft Computing", Prentice Hall of India Private Limited, 2002.*
2. *Klir and Yuan, "Fuzzy sets and Fuzzy Logic; Theory and Applications", Prentice Hall of India Private Limited 2009.*

15EEE344 HIGH VOLTAGE ENGINEERING 3 0 0 3

Unit 1

Introduction: different types of dielectrics, uniform and non-uniform electric field, electric field in some geometric boundaries.

Conduction and breakdown in gases: Collision process, ionization process, Townsend's theory, streamer theory, Pashen's law, breakdown in non-uniform fields and corona discharges - Vacuum insulation.

Conduction and breakdown in liquid dielectrics; Classification of liquid dielectrics, breakdown in liquid dielectric. Different types of solid dielectric materials - breakdown in solid dielectrics - field configuration in the presence of voids.

Breakdown in composite dielectric.

Unit 2

Generation of high voltages - ac voltages, dc voltages, impulse voltages. Generation of impulse currents.

Measurement of high voltages and currents - High DC, AC and impulse voltages, Direct, Alternating and Impulse currents.

Unit 3

Non-destructive insulation test techniques, measurement of insulation resistance under dc voltage, measurement of loss angle and capacitance, partial discharge measurement.

Testing of high voltage apparatus based in International and Indian standards - non-destructive testing - testing of insulators – bushings – cables - isolators and circuit breakers – transformers - surge arresters.

TEXTBOOK:

M. S. Naidu and V. Kamaraju, "High voltage Engineering", Second Edition Tata McGraw-Hill, Publishing Company Limited, 1995.

REFERENCES:

1. *C. L. Wadhwa, "High voltage Engineering", New age international (p) Ltd, Publishers, Reprint, 2001*
2. *Kuffel. E and Abdullah. M, "High Voltage Engineering", Pergamon press, Oxford, London, 1970.*
3. *Gallghar P. J. and Pearmain A. J, "High voltage measurement, Testing and Design", John Wiley & Sons, New York, 1982.*
4. *Kuffel E. and Zaengl W. S, "High voltage Engineering. Fundamentals", Pergamon press, Oxford, London, 1986.*

15EEE345 ILLUMINATION ENGINEERING 3 0 0 3

Unit 1

Radiant energy and visible spectrum, energy conversion to light, colour, eye and vision; different entities of illuminating systems.

Light sources: daylight, incandescent, electric discharge, fluorescent, arc lamps and lasers; Energy efficient lamps; Luminaries, wiring, switching and control circuits.

Unit 2

Laws of illumination; illumination from point, line and surface sources. Photometry and spectrophotometry; photocells. Environment and glare. General illumination design, Illumination levels, loss factors, lamp selection and maintenance.

Interior lighting – industrial, residential, office departmental stores, indoor stadium, theater and hospitals.

Unit 3

Exterior lighting - flood, street, aviation and transport lighting, lighting for displays and signaling - neon signs, LED-LCD displays beacons and lighting for surveillance.

Energy Conservation codes for lighting; lighting controls – daylight sensors and occupancy sensors; controller design.

TEXTBOOK:

Craig DiLouie, "Advanced Lighting Controls: Energy Savings, Productivity, Technology and Applications", CRC Press, 2005

REFERENCES:

1. *Kao Chen, "Energy Management in Illuminating Systems", Carlsons Consulting Engineers, San Diego, California, USA, CRC Press, 1999*
2. *Mark Stanley Rea, "IESNA Lighting Handbook", Illuminating Engineering Society of North America, 2000*
3. *Soni, Gupta and Bhatnagar, "A Course in Electrical Power", Fourth Edition, Dhanpat Rai & Sons, 1996.*

15EEE346 INDUSTRIAL ELECTRONICS 3 0 0 3

(Prerequisite: 15EEE201 Analog Electronic Circuits)

Unit 1

Input transducers and Sensors: Position, displacement, velocity, acceleration, force, flow pressure, level temperature, humidity. Telemetry 0-10V and 4-20mA systems.

Thermocouples, RTD, LVDT, Servo-pots, strain gauges, P, PI, PID converters, average to rms converters.

Actuators, DC and AC stepper motors, Dosing equipment weigh feeders, dosing pumps, extrusion – bulk and film electronic components. Medical equipments.

Unit 2

Programmable controllers and PLCs. Rotory encoders, digipots.

Automation: Transfer machines, robotics basics, Application of PLCs,

Industrial heating: Arc furnace, high frequency heating, High frequency source for induction heating, dielectric heating and microwave heating, Ultrasonic - Generation and applications.

Unit 3

High voltage equipments: voltage multipliers, electrostatic charging, precipitation, and painting. Plasma torches, particle accelerators electron beam welding, ion implantation, thrusters and gas lasers. Case studies of industrial applications.

TEXTBOOK:

Charles A. Schuler and William L. Mc. Namee, "Industrial Electronics and Robotics" International McGraw Hill, 1986.

REFERENCES:

1. *S. K. Bhattacharya and S. Chatterjee, "Industrial Electronics & Control", Tata McGraw Hill, 2003.*

2. Terry. L. M. Bartell, "Industrial Electronics", Delmer Publishers, 1997
3. Thomas E. Kissell, " Industrial Electronics", 2002

15EEE347 INTRODUCTION TO COMPUTER NETWORKS 3 0 0 3

Unit 1

Introduction to computer networks:
Uses of Computer Networks, Network Hardware, Network Software, Network Reference Models, Example Networks - The Internet, Connection - Oriented Networks: X.25, Frame Relay, ATM, Ethernet,
Physical Layer
Guided Transmission Media, Wireless Transmission, Public Switched Telephone Network - Structure of the Telephone System, Local Loop: Modems, ADSL, Multiplexing, Switching.

Data Link Layer (Logical Link layer)
Data link layer design issues: Framing, Error Control, Flow Control.

Error detection and correction, Error-Correcting Codes, Error-Detecting Codes, Data link protocols: Stop-and-Wait protocol, Sliding Window Protocols.

Unit 2

Data Link layer (MAC Layer)
MULTIPLE ACCESS CONTROL PROTOCOLS – ALOHA, Carrier Sense Multiple Access Protocols, Collision-Free Protocols, Limited-Contention Protocols, ETHERNET, Repeaters, Hubs, Bridges, Switches, Routers and Gateways.

Network Layer - Network Layer Design Issues, IP addressing, Routing Algorithms, ARP, RARP.

Unit 3

Transport Layer
Transport Service, Elements of Transport Protocols, Internet Transport Protocols - TCP, UDP Application Layer: DNS, electronic mail.

Security in Computer Networks.

Principles of Cryptography, Symmetric-Key Algorithms, Public-Key Algorithms.

TEXTBOOKS:

1. William Stallings, "Data and Computer Communications", 7th Edition, Pearson Education Asia, 2004.
2. Andrew S Tanenbaum, "Computer Network", Fourth Edition, Pearson Education, 2003

REFERENCES:

1. James F Kurose and Keith W Ross, "Computer Networking – a Top Down Approach Featuring the Internet", Second Edition, Pearson Education, 2003
3. Berhouz A Forouzan, "Data Communication and Networking", 3rd Edition, Tata McGraw Hill, 2004.

15EEE348 MANAGEMENT OF POWER DISTRIBUTION 3 0 0 3

Unit 1

Introduction: Energy security, Future of electricity, Electricity Acts and Regulations. Demand Forecasting: Forecasting techniques and forecasting modelling. Cogeneration, Wheeling and banking, Power pooling and trading, Energy storage schemes. Distribution reform, Quality of supply and Bench marking.

Unit 2

Change management in Power Distribution: Change management: Concepts and processes, Change requirement, Emerging developments.

Energy Management: Supply side management – issues and remedial measures. Demand Side Management, demand response, storage.

Unit 3

Distribution in deregulated market, Micro Economics in distributed generation, Micro grid, Distribution automation, SCADA, Smart Meters and its applications.

TEXTBOOKS / REFERENCES:

1. Pabla. A. S., "Electrical Power System Planning", Macmillan India Ltd., 1998.
2. Heinz Weihrich, Harold Koontz, "Management - A Global Perspective", Tenth Edition, Tata McGraw Hill, 2001.
3. IEEE working group on distribution automation, IEEE tutorial course 88EH0280-8-PWR, 1998.
4. M. Shahidehpour and M. Alomoush, "Restructured Electric Power Systems – Operations, Trading and Volatility", CRC Press, 2001.

15EEE349 NETWORK SYNTHESIS 3 0 0 3

Unit 1

Network functions, two port parameters, Interconnection of two ports, incidental dissipation, analysis of ladder networks.

Elements of realizability theory, causality and stability, Hurwitz polynomial, Positive real functions, synthesis procedure.

Unit 2

Synthesis of one port network with two kind of elements, properties of LC

immitance function, synthesis of LC driving point immitance, properties of RC driving point impedance, synthesis of RC and RL admittance, properties of RL impedance and RC admittance, synthesis of RLC function.

Unit 3

Elements of transfer function synthesis, properties of transfer function, zero of transfer function, synthesis of Y21 and Z21 with 1O termination, synthesis of constant resistive network.

Filter design, filter design principles, approximate problem, transient response of low pass filter, synthesis of low pass filter, magnitude and frequency normalization, frequency transformation.

TEXTBOOKS:

1. *Franklin F Kuo, "Network Analysis and Synthesis", John Wiley & Sons, Third Edition, 1966, reprint 2002.*
2. *A Sudhakar, Shyammohan S Palli, "Circuits and Networks – Analysis and Synthesis", Second Edition, Tata Mc Graw Hill Publication, 2006.*

15EEE350 OPTOELECTRONICS AND LASER INSTRUMENTATION 3 0 0 3

Unit 1

Introduction - Characteristics of optical radiation, luminescence, irradiance - Optical Sources - Photo Detectors - Opto-couplers and their application in analog and digital devices. Optical Fiber Fundamentals - modes, types of optical fibers - fiber coupling - Fiber optic sensors for common industrial parameters - V, I, pressure, temperature - IR sources and detectors - fiber optic gyroscope.

Unit 2

Characteristics of LASERS - Einstein's equations - population inversion two, three and four level system. Laser rate equation, properties – modes - Resonator configurations - Q switching and mode locking, cavity dumping, single frequency operation - Types of Lasers. Applications - Lasers for measurement of distance and length, velocity, acceleration, atmospheric effects, pollutants.

Unit 3

Material processing applications - Laser heating, melting, scribing, splicing, welding and trimming of materials, removal and vaporization.

Holographic Interferometry and Applications – Holography for non-destructive testing – medical applications - lasers and tissue interaction -surgery – dermatology.

TEXTBOOKS:

1. *Wilson and Hawkes, "Opto Electronics - An Introduction", Third Edition, Pearson Education, 1998.*
2. *John Ready, "Industrial Applications of Lasers", Second Edition, Academic Press, 1997.*

REFERENCES:

1. *Bhattacharya P, "Semiconductor Optoelectronics", Second Edition, Pearson Education, 1998.*
2. *Djafar K. Mynbaev, Lowell L. Scheiner, "Fiber-Optic Communications Technology", First Edition, Prentice Hall of India Pvt. Limited, 2000.*
3. *R. P. Khare, "Fiber Optics and Optoelectronics", Oxford Press, 2004*

15EEE351 POWER CONVERTERS 3 0 0 3

(Prerequisite: 15EEE313 Power Electronics)

Unit 1

DC-DC Switched Mode Converters: Operating principles, Steady state analysis for continuous and discontinuous current operations, Performance calculations of Buck converter, Boost converter, Buck-boost converter, Cuk converter & Full bridge converter - Comparison of DC-DC converters.

Unit 2

Switched Mode DC Power Supplies: Overview of linear and switched mode power supplies, Other types of converters: Flyback converter, Forward converter, Push pull converter, Half bridge converter & Full bridge converter.

Unit 3

Design of snubbers, drive circuits, magnetics, Voltage feed forward - PWM control and current mode control, Feedback compensators, unity power factor rectifiers.

Introduction to resonant converters - classification of resonant converters - Basic resonant circuit concepts. Zero current and Zero voltage switching.

Simulation of DC-DC converters and complete SMPS systems.

TEXTBOOK:

Ned Mohan et.al, 'Power Electronics', Third edition, John Wiley and Sons, 2003.

REFERENCES:

1. *George C. Chryssis, 'High Frequency Switching Power Supplies', McGraw-Hill International, 1999.*
2. *Otmar Kit Genstein, 'Switched Mode Power Supplies', John Wiley & Sons, 1994.*
3. *Abraham I. Pressman, 'Switching Power Supply Design', McGraw-Hill Company Inc, 1999.*
4. *Rashid, 'Power Electronics circuits, Devices, and Applications', Third Edition, Pearson Education, 2003*

15EEE352 POWER PLANT INSTRUMENTATION 3 0 0 3

Unit 1

Introduction to Unit operation and Unit Process: Material and Energy Balance. Significance of Instrumentation and layout of thermal, hydroelectric, nuclear, gas turbine, solar, wind Power plants.

Instrumentation and Equipments of Various Unit Operations: Evaporation, Distillation, leaching, Gas Absorption, Heat exchangers, Humidification and Dehumidification, Drying, Size Reduction, Crystallization, Mixing.

Unit 2

Boiler Instrumentation and Optimization: Combustion control, 3 element drum level control, steam pressure, oxygen / CO / CO2 – flue gases control, furnace draft, boiler interlocks, SCADA controls - Boiler inspection and safety procedures.

Turbine Instrumentation and Control: Valve actuation, auto-start up, start up and shut down, thermal stress control, condition monitoring and Power Distribution Instrumentation. Auxiliary control of water treatment plant, Electrostatic Precipitator and Oil Automation System.

Unit 3

Automation: Thermal power plant, Boiler Automation – Diagnostic Functions and Protection – Digital Electro – Hydraulic Governor, Man-Machine Interface - Graphic Display of Automated Power plant.

TEXTBOOKS:

1. *McCabe W. L, Smith J, Peter Harriot, "Unit operation of chemical Engineering", Seventh Rev Edition, Tata McGraw Hill Publishing Company, 2005.*
2. *Popovic and Bhatkar, "Distributed Computer control in Industrial automation", Second Edition, CRC Press, 1990.*

REFERENCE:

B. G. Liptak, "Instrument Engineers Handbook: Process Measurement and Analysis", Third Edition, Butterworth Heinemann, 1995.

15EEE353 POWER QUALITY 3 0 0 3

Unit 1

Introduction to power quality concepts: Need for PQ improvement, causes & effects - effects on utility side, and effects on customer side, Terms & definitions of power quality indices, PQ standards - IEEE / IEC.

Unit 2

Harmonic Analysis: Major sources, Minor sources of harmonics, Measurement and analysis techniques for harmonics.

Unit 3

Power Quality Improvement: Conventional compensation & FACTS compensation, Types of FACTS controllers, Control of FACTS devices, Tuned filters, Design of filters, Active filters- review of active filters, basic functioning of shunt & series active filters, Control of active filters,Hybrid filters - review of hybrid filters, working.

Improved power quality converters (IPQC) - review of IPQCs. Custom power-park, Custom power devices.

TEXTBOOK:

M. H. J Bollen, 'Understanding power quality problems', IEEE Press, 1999.

REFERENCES:

1. *J. Arillaga, N. R. Watson and S. Chen, 'Power system quality assessment', Wiley, 1999.*
2. *Narian G. Hingorani, and Laszlo Gyugyi, 'Understanding FACTS concepts and technology', IEEE Press, 2003.*
3. *T. J. E Miller, 'Reactive power control in electric systems', John Wiley & Sons, 1982.*
4. *C Sankaran, "Power Quality", CRC Press, 2001*

15EEE354 POWER SYSTEM MANAGEMENT 3 0 0 3

Unit 1

Introduction: Energy security, Future of electricity, Electricity Acts and Regulations. Demand Forecasting: Forecasting techniques and forecasting modelling. Utility Planning: Generation mix, Conventional and non-conventional generation, Cogeneration, Wheeling and banking, Power pooling and trading, Energy storage schemes. Concepts of smart grid.

Unit 2

Power System Economics: Time value of money, Methods of depreciation, Payback Calculation, Cost-benefit analysis, Internal rate of return, Net present value, Life cycle coating. Power Supply Reliability: Power system reliability indices, reliability evaluation.

Unit 3

Energy Management: Supply side management – issues and remedial measures. Demand Side Management. Operation Planning: Operation and maintenance, reactive power management. Energy Audit.

TEXTBOOKS / REFERENCES:

1. *Pabla A. S., "Electrical Power System Planning", Macmillan India Ltd., 1998.*

2. *Wood A. J. and Wollenberg B. F., "Power Generation, Operation and Control", Wiley Interscience, 1996.*
3. *Stoll H. G., "Least Cost Electric Utility Planning", Wiley Interscience, 1996.*
4. *Khan E., "Electrical Utility Planning and Regulation", American Council for Energy Efficient Economy, Washington DC, 1968.*

15EEE355 POWER SYSTEM PROTECTION AND SWITCHGEAR 3 0 0 3

Unit 1

Nature, causes and consequences of faults - Fault statistics - Need for protection - Essential qualities of protection - Types of protection – Primary and back up protection - Instrument Transformers - Basics of switchgear - Fuses, isolators, Earthing switches.

Development of protective relays - Recent developments - Operating principle - Classification of relays based on construction - Electromagnetic relays, Thermal relays, Overview of Static and Microprocessor relays, Numerical Relays - Introduction, Block diagram, Sampling theorem, Anti–Aliasing Filter, Least square method for estimation of phasor, concept of Discrete Fourier Transform to estimate the phasor.

Unit 2

Apparatus protection - Bus Bar protection, Transmission Line protection - realization of distance relays using numerical relaying algorithm, Introduction to wide area measurement (WAM) system - Generator protection - Motor Protection - Transformer Protection.

Overvoltage protection - Lightning arresters - Operating principle and types of arresters, Surge absorbers - Insulation co-ordination.

Unit 3

Circuit breakers - Operating principle - Arc phenomenon, principle, DC and AC Circuit Breaking - Problems of circuit interruption - Interruption of capacitive currents, Current chopping, Resistance Switching and methods of arc extinction - Arc interruption theories - Arc voltage, restriking voltage, Recovery voltage.

Types of circuit breaker – Construction and Operating Principle – HVDC circuit breaker - Selection of circuit breaker and its ratings - Auto reclosing.

TEXTBOOKS:

1. *Ravindra P. Singh, "Switchgear and power system protection", Prentice Hall of India, 2009*
2. *Badri Ram & D N Vishwakarma, "Power system protection and switch gear", Tata McGraw Hill Education, 2001.*

3. *T. S. Madhava Rao, "Power system protection: Static Relays", Tata McGraw Hill Education, 1989.*

REFERENCES:

1. *A. S. Ingole, "Switchgear and protection" Umesh publication, 2006*
2. *B. Ravindranath and M. Chander, "Power system protection and switchgear", New age International (P) Ltd., 2003*
3. *C. Christopoulos and A. Wright, "Electrical power system protection", Springer International edition, 2010.*
4. *Hadley, et al. Securing Wide Area Measurement Systems, Pacific Northwest National Laboratory. June 2007. URL:http://www.oe.energy.gov/DocumentsandMedia/Securing_WAMS.pdf*

15EEE356 POWER SYSTEM STABILITY 3 0 0 3

Unit 1

Introduction to power system stability problem - Basic concepts and definitions of rotor angle stability, voltage stability and voltage collapse - Mid term and long term stability - Classification of stability - Small signal stability - Fundamental concepts of stability of dynamic systems - Small signal stability of a single machine infinite bus system - Effects of excitation system.

Unit 2

Small signal stability of multi-machine systems - Characteristics of small signal stability problems - Transient stability - An elementary view of transient stability - Simulation of power system dynamic response – Performance of protective relaying - Case study.

Unit 3

Sub synchronous oscillations – Introduction - Torsional interaction with power system - Voltage stability - Basic concepts - Voltage collapse - Prevention of voltage collapse - Mid term and long term stability - Nature of system response severe upsets - Case studies.

Methods of improving stability - Transient stability enhancement - Small signal stability enhancement.

TEXTBOOK:

Prabha Kundur, "Power system stability and control", Tata McGraw Hill,2006

REFERENCES:

1. *K. R. Padiyar, "Power system dynamics - stability and control", B. S. Publications, 2008*
2. *Peter W. Sauer and M. A. Pai, "Power system dynamics and stability", Pearson Education, 2003.*

15EEE357 POWER SYSTEMS OPERATION, CONTROL AND STABILITY 3 0 0 3

(Prerequisite: 15EEE402 Electrical Energy Systems II)

Unit 1

Power system operation – state transition and control – data acquisition, state estimation, security assessment and security enhancement – functions of control centers – system load variations – system load characteristics – Real and Reactive power flows and control.

Unit 2

Basic P-f and Q-V loops, Load frequency control - modeling, analysis and control of single and multi-area – tie line with frequency bias control. Need for Automatic Voltage regulator – Modeling – static and dynamic analysis – Reactive power - voltage control devices. Economic load dispatch with and without losses – solution by iteration method (no derivation of loss coefficient) – Base point and participation factor – Economic controller added to LFC.

Unit 3

Power System stability – classifications – Rotor angle stability – small signal stability – Effects of excitation system – Power system stabilizer – sub synchronous oscillations – Voltage stability – Voltage collapse – Methods to improve stability.

TEXTBOOK:

1. *Olle I. Elgerd, "Electric Energy Systems Theory – An Introduction", Tata McGraw Hill Publishing company, 2004.*
2. *Prabha Kundur, "Power System stability and control", Tata McGraw Hill, 2006.*

REFERENCES:

1. *Kothari, D. P. and Nagrath, I. J., "Modern Power System Analysis", Tata McGraw Hill Publishing Company, 2003.*
2. *Allen J. Wood and Bruce F. Wollenberg, "Power Generation Operation and Control", John Wiley & Sons, 1984.*
3. *L. K. Kirchmayer, "Economic operation of Power System", John Wiley & Sons, 1953.*

15EEE358 PROCESS CONTROL AND INSTRUMENTATION 3 0 0 3

Unit 1

Introduction to process control, process variables, degree of freedom, Industrial measurement systems – different types of industrial variables and measurement systems elements – sensors and transducers for different industrial variables like pressure, torque, speed, temperature etc. – sensor principles – examples of sensors – sensor scaling – Industrial signal conditioning systems - Amplifiers – Filters – A/D

converters for industrial measurements systems – review of general Industrial instruments - I/P and P/I converters, pneumatic and electric actuators, valve positioned, control valves - characteristics of control valves, inherent and installed characteristics, valve body, globe, butterfly, diaphragm, ball valves, control valve sizing, cavitations and flashing, selection criterion, Servo drives, Stepper motor drives.

Unit 2

Process modeling, characteristics of liquid systems, gas systems, thermal systems, mathematical model of first order level, pressure and thermal process - higher order process, interacting non-interacting systems.

Basic control actions, characteristics of ON-OFF, P, I and D control, PI, PD and PID control modes, Response of controllers for different types of test inputs, pneumatic and electronic controllers to realize various control actions, selection of control mode for different processes, optimum controller settings, tuning of controllers - process reaction curve method, continuous cycling method, damped oscillation method, Ziegler Nichols methods.

1/4 decay ratio, feed forward control, ratio control, cascade control, averaging control, multivariable control, hybrid control, expert systems.

Distillation column, control of top and bottom product compositions, reflux ratios, control of chemical reactors, control of heat exchanger, steam boiler, drum level control and combustion control, P&I diagrams

Unit 3

Model predictive control - Batch Process control - Plant-wide control & monitoring – Plant-wide control design - Instrumentation for process monitoring - Statistical process control - Introduction to Fuzzy Logic in Process Control - Introduction to OPC - Introduction to environmental issues and sustainable development relating to process industries.

Process Automation - Role of digital computer system in process control, Distributed instrumentation and control system - PLC, DCS, SCADA.

TEXTBOOK:

Stephanopoulos. G, "Chemical Process Control", Prentice Hall of India, New Delhi, 1984

REFERENCES:

1. *Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp, "Process Dynamics and Control", Wiley Dreamtech India (P) Ltd, New Delhi, 2004*
2. *Ernest O. Doebelin "Measurement systems application and design", McGraw Hill International Editions, McGraw Hill Publishing Company, 2004*

3. *B. Wayne Bequette, "Process control, modeling, Design and simulation", Prentice Hall of India (P) Ltd., 2003*
4. *Steve Mackay, Edwin Wright, John Park, "Practical Data Communications for Instrumentation and Control", Newness Publications, UK, 2003*

15EEE359 RENEWABLE ENERGY AND ENERGY CONSERVATION 3 0 0 3

Unit 1

Historical development of energy demand and supply systems. Impact of fossil fuel based systems. Energy scenario – global and national; Renewable energy potential – global and national. Renewable energy technologies – stand-alone, hybrid and grid-connected systems.

Solar Energy: Solar radiation, its measurements and analysis. Solar angles, day length, angle of incidence on tilted surface, Sunpath diagrams, Shadow determination. Extraterrestrial characteristics, Effect of earth atmosphere, measurement & estimation on horizontal and tilted surfaces.

Principle of Photovoltaic Conversion - Dark and illumination characteristics, Figure of merits of solar cell, Efficiency limits, Variation of efficiency with band-gap and temperature. Equivalent circuit. Crystalline and thin - film cells. Multi-junction cells. Concentrated PV cell.

Module,panel and array – series and parallel connections. Maximum power point tracking. SPV applications - battery charging, pumping and lighting, power plant. PV system design.

Small Hydro Power - Resource assessment, Environmental restrictions, SHP schemes – types, construction and equipment selection, Load frequency control.

Unit 2

Wind Energy: Atmospheric circulations. Wind shear and turbulence. Wind monitoring and resource assessment; Weibull parameters. Classification of wind regimes.

Aerodynamic principles - lift and drag forces. Power coefficient and Betz limit. Types and characteristics of wind turbines.

Wind electric generation systems – grid-connected systems: WT-IG, WT-DWIG, WT-DOIG, WT-PMG and WT-VSIG. Comparison of performance. Economic performance.

Development of windfarms, site selection, wake effect, performance indices.

Small WEGs – stand-alone and hybrid systems.

Unit 3

Biomass energy – Gasifiers and dual fuel engines; Ocean-thermal energy conversion; Tidal energy conversion; Wave energy conversion; Geothermal energy conversion; MHD; Hydrogen and fuel cells.

Energy Conservation in electrical equipment: Energy efficient lighting – luminous efficiency of lamps, efficient lamps, energy conservation codes and lighting design. Energy conservation in motors – estimation of operating efficiency of industrial motors, right selection of motor ratings, energy efficient motors; auto-stop control, delta-star operation, voltage control; Energy conservation in variable speed operation of pumps and fans – demerits of mechanical resistance control, advantages of variable speed drives, specific energy consumption, system design using VSD.

TEXTBOOKS / REFERENCES:

1. *Thomas B Johansson et al, "Renewable Energy sources for fuel and electricity", Earthscan Publishers, London,1993*
2. *J W Twidell and A D Weir, "Renewable Energy Resources", ELBS, 1998.*
3. *G. N. Tiwari, M. K. Ghosal, "Fundamentals of renewable energy sources", Alpha Science International Ltd., 2007.*
4. *Garg H P., Prakash J., "Solar Energy: Fundamentals & Applications", Tata McGraw Hill, New Delhi, 1997*
5. *Kastha D, Banerji S and Bhadra S N, "Wind Electrical Systems", Oxford University Press, New Delhi,1998*
6. *Tony Burton, David Sharpe, Nick Jemkins and Ervin Bossanyi, "Wind Energy Hand Book", John Wiley & Sons, 2004*
7. *S. C. Tripathy, "Electric energy utilization and conservation", Tata McGraw Hill Publishing company Ltd.,1987*

15EEE360 SMART GRID 3 0 0 3

Unit 1

Concept of Smart Grid, Definitions, Need and Functions of Smart Grid, Opportunities & Barriers of Smart Grid. Today's grid versus smart grid.

Present development & International policies in Smart Grid. Smart Grid – Overview and stakeholders.

Unit 2

Smart Grid Technologies: Communication Technologies for Smart Grid, Interoperability and connectivity,

Layered Architecture and Protocols, Standards for Information Exchange. Information Security in smart grid - Encryption and decryption, Authentication, Digital Signatures,

Cyber Security standards. Smart Meters, Demand response. Distribution Side automation and Transmission side automation – PMU. Power electronics in Smart grid.

Unit 3

Renewable Energy and Storage Technologies – Distributed generation and storage. Interfacing of RE generation systems and energy storage systems on Smart Grid.

TEXTBOOKS / REFERENCES:

1. *James Momoh, "Smart Grid: Fundamentals of Design and Analysis", Wiley-IEEE Press, March 2012.*
2. *Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley, February 2012.*
3. *Nouredine Hadjsaïd, Jean-Claude Sabonnadière, "Smart Grids", Wiley-ISTE, May 2012.*
4. *Ali Keyhani and Muhammad Marwali, "Smart Power Grids 2011", Springer, 2011.*

15EEE361 SPECIAL ELECTRIC MACHINES 3 0 0 3

Unit 1

Stepping Motors

Introduction to all kinds of special machines, stepper motor, reluctance motors, hysteresis motors, brushless motors etc. Constructional features, Principle of operation, Variable reluctance motor, Hybrid motor, Single and multi-stack configurations, Torque equations, Modes of excitations, Characteristics, Drive circuits, Microprocessor control of stepping motors, Closed loop control.

Unit 2

Synchronous Reluctance Motors

Constructional features, Types, Axial and Radial flux motors, Operating principles, Variable Reluctance and Hybrid Motors, Voltage and Torque Equations, Phasor diagram, Characteristics.

Switched Reluctance Motors

Constructional features, Rotary and Linear SRMs, Principle of operation, Torque production, Steady state performance prediction, Analytical method, Power Converters and their controllers, Methods of Rotor position sensing, Sensor less operation, Closed loop control of SRM, Characteristics.

Unit 3

Permanent Magnet Synchronous Motors

Permanent Magnet materials, Magnetic Characteristics, Permeance coefficient, Re - coil of a magnet, Principle of operation, Ideal PMSM, EMF and Torque equations, Armature reaction MMF.

Brushless D.C. Motors

Principle of Operation, Types, Magnetic circuit analysis, EMF and torque equations, Commutation, Power Controllers, Motor characteristics and control, Torque/speed characteristics,

TEXTBOOK:

S. A Nasar and I. Boldea, L. E. Unnewehr permanent magnet, "Reluctance and self–synchronous motors", CRC Press inc.1993.

REFERENCES:

1. *Miller, T. J. E. "Brushless permanent magnet and reluctance motor drives", Clarendon Press, Oxford, 1989.*
2. *T. J. E. Miller (Ed.), "Electronic Control of Switched Reluctance Motor", Newman Power Engineering Series, 2001.*
3. *Paul Acamley, "Stepping Motor – A Guide to Theory and Practice", IEE London. 2002.*
4. *B. K. Bose, "Modern power electronics and AC drives", Prentice Hall of India, N J, 2002.*

15EEE362 UTILISATION OF ELECTRIC ENERGY 3 0 0 3

Unit 1

Electric Lighting - Definition of terms; laws of illumination; Luminaries; Lighting requirements; Illumination levels; lamp selection and maintenance; Lighting schemes, calculations & design – Interior lighting – industrial, Factory, residential lighting; Exterior lighting - Flood, street lighting, lighting for displays and signaling - neon signs, LED - LCD displays beacons and lighting for surveillance; Energy Conservation codes for lighting; lighting controls – daylight sensors and occupancy sensors; controller design.

Unit 2

Electric Drives - Selection of motors in various applications; Electric drive systems in various industries; speed control of motors, variable speed drives, Specifications of commonly used motors. Energy efficient drives.

Space conditioning systems - Heating, Ventilation, and Air Conditioning (HVAC) systems: Principle of air conditioning, vapour pressure, refrigeration cycle, eco - friendly refrigerants; Electrical Circuits used in Refrigeration and Air Conditioning and Water Coolers;

Electrochemical Processes - Electrolysis. Electroplating. Electrodeposition. Extraction of metals.

Unit 3

Electric Heating – Comparison with other heating methods; Resistance heating,

Induction heating, Arc furnace, Dielectric heating; Electric welding – types, equipment and modern techniques.

Electric Traction - Traction systems; Speed-time curves and mechanics of train movement; Traction motors; Control of motors; Electric braking methods; Regeneration. Electric Vehicles – Types of electric vehicles and hybrid vehicles; motors and batteries for EV; Drive systems for electric traction.

TEXTBOOK:

S C Tripathy, "Electric Energy Utilisation and Conservation", Tata McGraw Hill, 1987.

REFERENCES:

1. *H Partab, "Art and Science of Utilisation of Electrical Energy", Dhanpat Rai & Co., 2014*
2. *Howard B Cary and Scott C Helzer, "Modern Welding Technology", Prentice Hall, 2004*
3. *Craig Di Louie, "Advanced Lighting Controls: Energy Savings, Productivity, Technology and Applications", CRC Press, 2005*
4. *William C. Whitman, William M. Johnson "Refrigeration & Air Conditioning Technology", Thomson Delmar, 2005*

15EEE381 DIGITAL SYSTEMS AND SIGNALS LAB. 0 0 2 1

Half adder and full adder implementation - Boolean Equation Implementation - Multiplexer and Demultiplexer implementation - Asynchronous and Synchronous counters Implementation using D, T and JK flip flops.

Generation of signals - ramp, sine, exponential, etc. using MATLAB; Discrete Linear Convolution implementation; Fourier transform and Fourier Series Implementations; DFT Implementation; Power signal analysis using FT/DFT.

15EEE382 ELECTRICAL MACHINES LAB. II 0 0 2 1

No load and load characteristics of three phase alternators - Regulation by different methods and efficiency calculation - no load, blocked rotor and load tests on single phase and three phase induction machines - Characteristics of synchronous induction motor and induction generator - Speed control and starting methods of AC machines - synchronization to infinite bus bars - V curves and inverted V curves of synchronous motor.

15EEE385 DSP AND MICROCONTROLLER LAB. 0 0 2 1

Simple logic programs to understand MPLAB; LED Blinking Program, Timer 0,1 and Timer 2 Programming; key board Interfacing; ADC-PWM interfacing with dc motor using PROTEUS.

DFT analysis' Circular convolution using m file; Filter Design using FDA tool and Testing; SIMULINK analysis of harmonic signal.

15EEE386 POWER ELECTRONICS LAB. 0 0 2 1

SCR characteristics, MOSFET switching characteristics, AC phase control using SCR, Triac and Diac, Single phase half controlled bridge converter, UJT Relaxation Oscillator for SCR triggering application, Series Inverter, Single phase transistorized inverter, Speed control of DC Motor using Chopper Drive, Simulation of full bridge converter, single phase single pulse width modulated MOSFET inverter, sinusoidal unipolar pulse width modulation.

15EEE387 OPEN LAB. 0 1 2 2

This is a hands - on sections for the students. By the sixth semester, the students are adept in different core streams like Power Electronics, Power Systems, Electrical machines, Energy systems, Digital Signal Processing etc. The students will apply their acquired knowledge and develop an application related to one or more of the core areas and implement a pragmatic setup, justifying the application.

15EEE390 / 15EEE490 LIVE-IN-LAB. 3 cr

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or rural sites during the vacations (after fourth semester or sixth semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth or seventh semester. The objectives and projected outcome of the project should be reviewed and approved by the Dept. chairperson and a faculty assigned as the project guide. On completion of the project, the student shall submit a detailed project report. The report shall be evaluated and the students shall appear for a viva-voce test on the project.

15EEE401 ELECTRIC DRIVES AND CONTROL 3 1 0 4

(Pre-requisite: 15EEE313 Power Electronics)

Unit 1

Introduction: Concepts, and classification of Electric drives. Selection of motors. Dynamics of Electric drives: Types of loads, Multi quadrant operations, motor dynamics steady state stability and transient stability. Rating and Heating of motors: Heating effects, heating and cooling curves, classes of duty, load equalization, environmental factors.

DC motor drives: Basic characteristics, Operating modes, Single phase and three phase controlled rectifier fed DC drives, Dual converters drives, Chopper drives, Rheostatic and regenerative braking, effects of changes in supply voltage and load torque, closed loop control schemes.

Unit 2

AC motor drives: Induction motor drives, stator voltage control, stator impedance control, rotor voltage control - Slip power recovery, Concepts of Static Kramer drives and Static Scherbius drive, V/f control, Current control method. Need for harmonic filter, Closed loop control. Introduction to vector control scheme.

Unit 3

Synchronous motors: Speed torque characteristics and torque angle characteristics. Fixed and variable frequency operation modes, Self-control modes.

Special machines: Brushless DC motor, Switched Reluctance Motor, introduction to the relevant converter circuits.

TEXTBOOK:

Gopal K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 2001.

REFERENCES:

1. *Pillay. S. K, A First Course on Electric Drives, Wiley Eastern Limited, Bombay, 2012*
2. *B. K Bose, 'Modern Power Electronics and AC Drives', Prentice Hall, New Jersey, 2002.*
3. *V. Subrahmanyam, 'Thyristor Control of Electric Drives', Tata McGraw Hill, New Delhi, 1988.*
4. *R. Krishnan, 'Electric Motor Drives, Modeling, Analysis and Control', Prentice Hall, NJ, 2001.*
5. *Muhammad H. Rashid, Power Electronics, Circuits, Devices and Applications, Third Edition, Pearson Education Press, 2004.*

15EEE402 ELECTRICAL ENERGY SYSTEMS II 3 1 0 4

(Pre-requisite: 15EEE312 Electrical Energy Systems I)

Unit 1

Single line diagram – per unit representation – power system modeling – bus admittance and impedance matrix – Load flow analysis – Gauss seidel, Newton Raphson and Fast decoupled load flow methods – comparison of methods.

Unit 2

Short circuit analysis – symmetrical faults – behavior of short circuit transients in generator and transmission line – selection of circuit breaker – symmetrical components – sequence diagram – unsymmetrical faults – open conductor fault – LG, LL and LLG faults.

Unit 3

Power System stability – dynamics of synchronous machine – swing equation – steady state and transient stability – equal area criterion – critical clearing time – Multi machine stability.

TEXTBOOK:

Kothari, D. P. and Nagrath, I. J., "Power System Engineering", Third Edition, Tata McGraw Hill Publishing Company, 2003.

REFERENCES:

1. *Kothari, D. P. and Nagrath, I. J., "Modern Power System Analysis", Tata McGraw Hill Publishing Company, 2003.*
2. *Hadisaadat, "Power System Analysis", McGraw Hill Publishing Company, 2003.*
3. *Wadwa, C. L., "Electrical Power Systems", Wiley Eastern Limited, India, 2007.*
4. *John J. Grainger and Stevenson Jr. W. D, "Power System Analysis", McGraw Hill International edition, 1996.*

15EEE481 DRIVES AND CONTROLS LAB. 0 0 2 1

DC Machine modeling and simulation; Phase-controlled DC Motor Drives; DC/DC Chopper Controlled DC Motor Drives; Induction Motor Drives; Stepper motor drive; Servo drive.

15EEE482 POWER SYSTEMS LAB. 0 0 2 1

Development of software packages to calculate line parameters, Load flow analysis, Short circuit analysis, Transient stability analysis, Power system transients, Load frequency dynamics and Economic dispatch.

15EEE495 PROJECT PHASE I 2 cr

Each student is to do a project and prepare a seminar paper related to Electrical Engineering in an approved format and present it at the end of the semester.

15EEE499 PROJECT PHASE II 10 cr

The project shall be focused on the synthesis of the knowledge gained over the past seven semesters, by taking up a work of relevance to Electrical and Electronics Engineering covering Design / Development / Realization / Application / Performance Analysis / State-of-the-art Technology.

15EIE201 INDUSTRIAL INSTRUMENTATION I 3 1 0 4

Unit 1

Introduction: Elements of a generalized instrumentation system – Classification of instruments - I/O Configuration – method of correction for spurious inputs – Static characteristics – Errors in measurements and their statistical analysis – Dynamic characteristics.

Unit 2

Measurement of Displacement Force, Torque, speed and Temperature: Displacement measurement – LVDT – Potentiometer- Force measurement - Electric balance - Magneto elastic load cell - Strain gauge load cell. Torque measurement: Strain gauge - Relative regular twist. Speed measurement: Revolution counter - Capacitive tacho - Drag cup type tacho - D.C and A.C tacho generators - Stroboscope. Temperature measurement: Bimetallic Thermometers – RTD – Thermistor – Thermocouple - Semiconductor thermometers - Radiation pyrometers.

Unit 3

Measurement of Flow and Pressure: Flow measurement – Variable head flow meters – Orifice – Venturi – Pitot tube – Rotameter – EM flow meter – Hotwire anemometers – Turbine flow meters – Ultrasonic meter – Vortex shedding flow meter – Nutating disc. Pressure Measurement: Dead weight tester – Manometers – Elastic pressure elements. Low pressure measurement: Mcleod's gauge – Viscosity gauge – Pirani Gauge – Thermocouple gauge – Ionization gauges.

TEXTBOOK:

1. *A. K. Sawhney, Puneet Sawhney, "A Course in Mechanical Measurements and Instrumentation". Dhanpat Rai and Company Private Limited, Twelfth Ed, 2007.*
2. *E. O. Doeblin, "Measurement system Application and design", Tata McGraw Hill Publishing Company Limited, Fifth edition, 2007.*

REFERENCES:

1. *R. K. Jain, "Mechanical and Industrial Measurements", Khanna Publishers, New Delhi, eleventh edition, 2007.*
2. *T. G. Beckwith, Roy D. Marangoni and John H. Lientar, "Mechanical Measurements", Pearson Education, fifth edition, 2006.*
3. *D. Patranabis, "Principles of Industrial Instrumentation", Wheeler Publishing Company Limited, Second edition, 2007.*

15EIE211 ELECTRICAL AND ELECTRONIC MEASUREMENTS 3 1 0 4

Unit 1

PMMC Instruments: galvanometer – DC ammeter – DC voltmeter – rectifier voltmeter - rectifier ammeter – Deflection instruments: series ohmmeter – shunt ohmmeter –

VOM meters. Electrodynamic instruments. Transistor voltmeter - op-amp Voltmeter – AC Electronic voltmeter – Current measurement – Digital multimeters – multimeter probes.

Unit 2

Resistance measurement: voltmeter and ammeter method - substitution method - Wheatstone's bridge. Low resistance measurements and instruments. High resistance measurement and instruments. AC bridge theory - capacitance and induction bridges - Q-meter.

Unit 3

CRO: CRT – Deflection amplifiers – waveform display – timebase – measurement of voltage – frequency and phase – pulse measurement – probes – X – Y and Z displays – DSO and its applications. Low-frequency signal generators – Function generators – Pulse generators – RF signal generator – Sweep frequency generator – frequency synthesizer – arbitrary wave form generator - Distortion meter – Spectrum analyser – Digital spectrum analyzer.

TEXTBOOK:

Bell, D A., "Electronic Instrumentation and Measurements", Oxford University Press, Third edition, 2013.

REFERENCES:

1. *Sawhney A. K., Sawhney P., "A Course in Electrical and Electronic Measurements and Instrumentation," Dhanpat Rai Publications, 2012.*
2. *Helfrick A. D., Cooper W D., "Modern Electronic Instrumentation and Measurement Techniques", PHI Learning, 2011.*
3. *Robert W, "Electronic Test Instruments: Analog and Digital Measurements", Pearson Education, second edition, 2009.*

15EIE281 INDUSTRIAL INSTRUMENTATION I LAB. 0 0 2 1

1. Characteristics of RTD, thermistor, Study of seebeck effect
2. Time constant of Mercury-in-glass thermometer and a Bimetal Thermometer
3. Calibration of venturimeter, orifice meter and a rotameter
4. Calibration of a pressure gauge using a dead weight tester (any two scales)
5. Study and plotting the characteristics of a LVDT
6. Study and plotting the characteristics of a Load cell
7. Study and plotting the characteristics of a Torque transducer
8. Study of the dynamic characteristics of a first order and second order system

15EIE285 MEASUREMENTS LAB. 0 0 2 1

1. Experiments with DC bridges
2. Experiments with AC bridges

3. Calibration of single phase energy meter
4. Calibration of WATT meter
5. Calibration of ammeter
6. Calibration of voltmeter
7. Experiments using CRO
8. Experiments using DSO
9. Experiments using DMM

15EIE301 ELECTRICAL MACHINES 3 1 0 4

Unit 1

Introduction to Machinery Principles – Electrical Machines: Faraday's Law – Induced Voltage from a Time-Changing Magnetic Field – Production of Induced Force on a Wire-Induced Voltage on a Conductor Moving in a Magnetic Field.

Transformers Types and Construction – Ideal Transformer – Theory of Operation of Real Single – Phase Transformers – Equivalent Circuit - Per-Unit System of Measurements - Voltage Regulation and Efficiency - Taps and Voltage Regulation - Autotransformer.

Unit 2

AC Machinery Fundamentals: Rotating Magnetic Field - Magneto-motive Force and Flux Distribution – Induced Voltage – Induced Torque –Power Flows and Losses – Voltage Regulation and Speed Regulation.

Synchronous Generators: Construction - Speed of Rotation - Internal Generated Voltage - Equivalent Circuit - Phasor Diagram - Synchronous Motors - Basic Principles of Operation - Steady-State Operation - Starting.

Unit 3

Induction motors: Construction – Basic Induction Motor Concepts - Equivalent Circuit - Power and Torque – Torque – Speed Characteristics –Variations in Torque – Speed Characteristics – Starting – Speed Control – single phase induction motor.

***DC Machines: simple DC machine - commutation and problems - power flow and losses - types equivalent Circuit - Magnetization Characteristic - separately excited – Shunt – PM - Series - Compounded DC Motors - Starting of DC Motors.
(*** optional)

TEXTBOOK:

S. J. Chapman, "Electric Machinery and Power Systems Fundamentals", McGraw-Hill, First edition, 2002.

REFERENCES:

1. *Bimbhra P S, "Electrical Machinery", Khanna Publishers, seventh edition, 2004.*
2. *Say M G, "Alternating Current Machines", Pitman, fifth edition, 1990.*
3. *Nagrath I J and Kothari D P, "Electrical Machines," Tata McGraw-Hill, third edition, 2004.*
4. *S. J. Chapman, "Electrical Machinery Fundamentals", McGraw-Hill, fourth edition, 2005*

15EIE311 INDUSTRIAL INSTRUMENTATION II 3 0 0 3

(Pre-requisite: 15EIE201 Industrial Instrumentation I)

Unit 1

Measurement of Level, Density and Viscosity: Level Measurement: Sight glass - Electrical methods – Pressure based detector - Buoyancy methods – Radiation based (gamma) and ultrasonic detectors. Density Measurement: Pressure head type densitometer – Float type densitometer – Ultrasonic densitometer – Bridge type gas densitometer. Viscosity measurement: Saybolt viscometer –Rotameter type viscometer – Industrial consistency meters.

Unit 2

Measurement of Acceleration, Vibration, Humidity and Moisture: Acceleration measurement: LVDT – Piezoelectric – Strain gauge –Variable reluctance type accelerometers – Seismic instrument as an accelerometer and vibrometer. Humidity measurement: Dry and wet bulb psychrometers – Hotwire electrode type hygrometer - Dew cell - Electrolysis type hygrometer - Commercial type dew point meter. Moisture measurement: Moisture measurement in granular materials – solid penetrable materials like wood – web type material.

Unit 3

Instrument design, Standards and Safety measures: Elements of design – Product lifecycle – Circuit design – Circuit layout – Assembly and Inspection – Testing and calibration. Metrology: SI units – Testing – Compatibility – Calibration and Traceability. Standards –Electrical standards – Time and Frequency standards – Standards in quality management. Instrumentation in hazardous areas.

TEXTBOOKS:

1. *R. K. Jain, "Mechanical and Industrial Measurements", Khanna Publishers, New Delhi, 11th Ed, 2007.*
2. *M. M. S. Anand, "Electronic Instruments and Instrumentation Technology", Prentice Hall of India Private Limited, 2006.*

REFERENCES:

1. *E. O. Doeblin, "Measurement system Application and design", Tata McGraw-Hill Publishing Company Limited, 5th Ed. 2007.*
2. *D. Patranabis, "Principles of Industrial Instrumentation", Wheeler Publishing Company Limited, 2nd Ed. 2007.*

15EIE312 PROCESS CONTROL 3 0 0 3

(Pre-requisite: 15ECE302 Control Systems Engineering)

Unit 1

Incentives for Chemical Process Control - Design aspects - Hardware for a Process Control System - Modelling of Chemical Processes: Development of a mathematical model with examples of STH and CSTR - State Variables and State Equations - Dead Time - linearization of Nonlinear systems - Input-output Model - Degrees of freedom and process controllers - Transfer function of a process with single/ multiple outputs. Dynamic Behavior of First Order - second order and higher order systems.

Unit 2

Controller Principles: Process characteristics - Control System Parameters - Discontinuous controller Modes - Two-Position - Multi position - Floating Control Mode - Continuous controller Mode – P - I and D - Composite control Modes: PI – PD - PID. Control action generation in electronic - pneumatic controllers – Direct Digital Control: components and working of DDC – benefits of DDC. Design of Feed Back controllers: Outline of Design problems - simple performance criteria - time integral performance content - selection of a feedback controller - controller tuning using Cohen-Coon method - Bode Stability criterion - gain and phase margins - Ziegler-Nichols Tuning Technique.

Unit 3

Control Valves: Terminology – control valve characteristics – valve classifications and types – valve positioned – selection criteria for control valves. P & I Diagram: Terminology – instrument identification - examples. Advanced control strategies: Cascade - Feed-forward – feedforward – feedback and Ratio Control.

TEXTBOOKS:

1. *Stephanopoulos, "Chemical Process control", PHI, 2006.*
2. *Surekha Bhanot, "Process Control - Principles & Applications," Oxford University Press, 2008*

REFERENCE:

C. D. Johnson, "Process control Instrumentation Technology," Pearson Education, Eighth Edition, 2006.

15EIE330 ADVANCED PROCESS CONTROL 3 0 0 3

(Pre-requisite: 15EIE312 Process Control)

Unit 1

Enhanced Single - Loop Control Strategies: Time-Delay Compensation - Inferential Control - Selective Control – Override Systems - Nonlinear Control Systems -

Adaptive Control Systems. Multiloop and Multivariable Control: Process Interactions and Control Loop Interactions - Pairing of Controlled and Manipulated Variables - Singular Value Analysis - Tuning of Multiloop. PID Control Systems - Decoupling - Multivariable Control Strategies - Strategies for Reducing Control Loop Interactions.

Unit 2

Real-Time Optimization: Basic Requirements in Real-Time Optimization - the Formulation and Solution of RTO Problems - Unconstrained Optimization - Linear Programming - Quadratic Programming - Nonlinear Programming. Model Predictive Control: Overview of Model Predictive Control - Predictions for SISO Models - Predictions for MIMO Models - Model Predictive Control Calculations - Set-Point Calculations - Selection of Design and Tuning Parameters - Implementation of MPC.

Unit 3

Process Monitoring: Traditional Monitoring Techniques - Quality Control Charts - Extensions of Statistical Process Control - Multivariate Statistical Techniques - Control Performance Monitoring. Batch Process Control: Batch Control Systems - Sequential and Logic Control.

TEXTBOOK:

Dale E. Seborg, Duncan A. Mellichamp, Thomas F. Edgar, Francis J. Doyle, III, "Process Dynamics and Control", Wiley, Third Ed, 2010.

REFERENCES:

1. *Stephanopoulos, "Chemical Process control", PHI, 2006.*
2. *B. Wayne Bequette, "Process Control: Modeling, Design and Simulation", Prentice Hall of India, 2006.*

15EIE331 DIGITAL CONTROL AND STATE VARIABLE METHODS 3 0 0 3

(Pre-requisite: 15ECE302 Control Systems Engineering)

Unit 1

Computer-Based Control: History - An Overview of the Classical Approach to Analog Controller Design. Digital Control: Need for Digital Control - Basic Digital Control Scheme - Signal Conversion - Basic Discrete - Time Signals. Time-Domain Models: Z-Transform - Transfer Function Models. Frequency response. Stability on the z-Plane: Jury Stability Criterion. Sample-and-Hold Systems - Sampled Spectra and Aliasing - Reconstruction of Analog Signals - Practical Aspects of the Choice of Sampling Rate - Principles of Discretization.

Unit 2

Models of Digital Control Devices and Systems: z-Domain Description of Sampled

data systems - and Systems with Dead-Time. Implementation of Digital Controllers. PID Controllers. Digital Temperature Control System - Digital Position Control System. Control System Analysis using state variable methods: State Variable Representation - State Variable Models to Transfer Functions - Transfer Functions to State Variable Models – Eigen values and Eigen vectors - Solution of State Equations. Concepts of Controllability and Observability: Multivariable Systems. State variable Analysis of Digital Control System: State Descriptions - Digital Processors. Sampled data systems -Systems with Dead-Time - Solution of State Difference Equations - Controllability and Observability - Multivariable Systems.

Unit 3

Pole-Placement Design and State Observers: Stability Improvement by State Feedback - Conditions for Arbitrary Pole-Placement-State Regulator Design - Design of State Observers - Compensator Design by the Separation Principle. Servo Design: Introduction of the Reference Input by feed forward Control - State Feedback with Integral Control - Digital Control Systems with State Feedback - Deadbeat Control by State Feedback and Deadbeat Observers.

TEXTBOOK:

M. Gopal, "Digital Control and State Variable Methods: Conventional and Intelligent Control", TMH, Third edition, 2008.

REFERENCES:

1. *Ogata. K., "Discrete - time Control Systems", Prentice Hall Inc, New Jersey, second Edition, 1995.*
2. *Kuo B. C, "Digital Control Systems", Oxford University Press, second Edition, 1995.*

15EIE332 EMBEDDED SYSTEMS FOR INSTRUMENTATION 3 0 0 3

Unit 1

Hardware Fundamentals: Introduction to Embedded Systems; Application Areas; Hardware / Software Architectures of Embedded System-Compiling; Linking and Locating;

Downloading and Debugging; Emulators and Simulators; Types of Memory; Flash Memory; Built-in on the Microprocessor Control and Status Register; Device drivers and its design; CISC / RISC - RTOS and Architectures; Selecting Architecture.

Unit 2

High performance RISC architecture: ARM processor; ARM Architecture; ARM Organization and Implementation, ARM Peripherals: I/O Port; Timers; ADC; PWM; USART; ARM Instruction set; THUMB Instruction set; Basic ARM Assembly Language Program; ARM CPU Cores. Real time operating systems: Tasks and Task States - Mutexes and Semaphores - Shared Data - Message Queues; Mail Boxes and

Pipes; Memory Management; Interrupt Routine; Encapsulating Semaphores and Queues; Hard Real Time Scheduling; Power Saving.

Unit 3

Case studies: Embedded C Programming; Multiple Closure Problems; Basic Outputs with PPI;

Controlling Motors; Bidirectional Control of Motors; H bridge; Real Time Clock; Relay Interfacing; LCD and Keyboard Interfacing; Temperature Sensor Interfacing.

TEXTBOOKS:

1. *David E. S., "An Embedded Software Primer", Pearson Education, Eighth edition, 2009.*
2. *Furber S., "ARM System on Chip Architecture", Addison Wesley, second Edition, 2000.*

REFERENCE:

Berger A. S., "Embedded System Design", CMP books, second Edition, 2002.

15EIE333 FIBER OPTICS AND LASER INSTRUMENTATION 3 0 0 3

(Pre requisite: 15EIE201 Industrial Instrumentation I)

Unit 1

Lasers: Principles and Types - Emission and absorption of radiation - Einstein relations - Absorption of radiation. Population inversion - 3 Level and 4 level systems – Optical feedback - LASER cavity mirror configurations. Threshold conditions - LASER losses. Line shape function (concept only). LASER modes - axial and transverse. Classes of LASER - solid state Lasers, semiconductor Lasers, gas Lasers, liquid dye Lasers.

Unit 2

LASER properties and Applications Single mode operation, mode locking, Q-switching, properties of LASER lights - directionality, line width, beam coherence etc. Applications - Overview (more detailed coverage for instrumentation related applications), Alignment, measurement of length, pollution detection, velocity measurement, holography, holographic interferometry, inspection, analytic technique, recording, communication, heat source, medical, printing, isotope separation, atomic fusion. Optical Fiber Fundamentals Physics of light, Refractive Index, Total internal reflection, Optical fiber basics, concept of mode, types of fibers, attenuation, dispersion, multimode and single mode fibers, light sources (LEDs and LDs) and detectors (PIN diode, APDs).

Unit 3

Optical Fiber Applications Overview - Communications, illumination and sensors. Fiber optic sensors - Advantage over conventional sensors, block diagram of fiber

optic sensors, intensity modulated sensors, phase modulated sensors, spectrally modulated sensors, distributed fiber optic sensors. Industrial applications of fiber optic sensors - Introduction, temperature measurement, pressure measurement, level measurement, flow measurement, vibration measurement, chemical analysis, current measurement, voltage measurement, issues for industrial applications. Fiber optic smart structures - Introduction, fiber optic sensor systems, applications of fiber optic smart structures and skins, example of Application of fiber optic sensors to smart structures.

TEXTBOOKS:

1. *Djafar and Lowell, "Fiber Optic Communication Technology", Pearson Education, 1st Reprint, 2001*
2. *J. Wilson and J. F. B Hawkes, "Optoelectronics - an Introduction", Prentice Hall of India, Second Ed., 2001*

REFERENCES:

1. *R. P Khare, " Fiber optics and Optoelectronics", Oxford University Press,2004*
2. *Eric Udd, "Fiber Optic Sensors-An Introduction for Engineers and Scientists", Wiley Interscience, 2006*
3. *William M. Steen, "Laser Material Processing", Springer International, Third edition, 2005*

15EIE334 INSTRUMENTATION PROJECT MANAGEMENT AND SYSTEM DESIGN 3 0 0 3

Unit 1

Project Management and Documentation - good practices - project criteria document – I & C documentation system - project management-an I & C perspective - Project Integration - Project Scope - Time - Cost - Quality - HR and Risk management - Procurement - Commissioning - start-up. Reliability engineering concepts- Importance of Reliability for Instrument Engineers - Probability - Statistics - and Block Diagram Analysis - Probability Laws Applied to Reliability - Discrete Distributions and Applications - Continuous Distributions and Applications - Reliability Measures.

Unit 2

Control Centers and Panels - Traditional and DCS Control Rooms - Traditional Control Panels - Traditional Front Panel Layouts - Panel Specifications - Human Engineering - Wiring practices and signal conditioning - Electric Noise - Grounding - Wiring - Filtering - Applications to thermocouple signal conditioning - Electronic Transmitters. Flowsheet symbols and functional diagramming - Definitions related to Flowsheet Diagram Symbology - Identification System Guidelines - Identification Letters - Graphic Symbol System Guidelines - Functional Diagramming for Digital Systems.

Unit 3

Control valves - Basic characteristics and operation of Ball - Plug - Globe - Butterfly

and Gate valves - Control Valve Trends - Control Valve Sizing - General Recommendations - Characteristics - Gain and Rangeability - Actuator Selection - Positioners - I/P Transducers - Energy Supplies.

TEXTBOOK:

Whitt M. D., "Successful Instrumentation and Control Systems Design," The Instrumentation, Systems, and Automation Society (ISA), Second Ed., 2012.

REFERENCES

1. *Liptak B. G., "Instrument Engineers' Handbook, Vol. I - Process Measurement and Analysis", Fourth Edition, CRC Press, 2011.*
2. *Liptak B. G., "Instrument Engineers Handbook, Vol. II: Process Control", Fourth Edition, CRC Press, 2011.*
3. *Liptak B.G, Eren H., "Instrument Engineers' Handbook, Volume 3: Process Software and Digital Networks", Fourth Edition, CRC Press, 2011.*

15EIE335 INTELLIGENT CONTROL SYSTEMS 3 0 0 3

Unit 1

Basic Concepts for Intelligent Systems: Artificial Neural Networks - Perceptral Networks - Radial Basis Function Networks - Back-propagation Networks and Recurrent Networks - System Identification Using Neural Networks - Fuzzy logic - Knowledge Representation - Fuzzy Sets - Fuzzy Rules and Reasoning - Fuzzy Logic Control - Mamdani Model - Takagi-Sugeno Model - System Identification using T-S Fuzzy Models.

Unit 2

Nonlinear Control: Nonlinear State-space Model - Lyapunov Stability Theory - Lyapunov's Indirect Method - Nonlinear Control Strategies Direct Adaptive Control Using Neural Networks: Direct Adaptive Control - SISO and MIMO Systems - Back-stepping Control.

Unit 3

Fuzzy Model Based Control: T-S Fuzzy model - Linear Matrix Inequality (LMI) Technique - Fixed Gain state Feedback Controller Design Technique - Variable Gain Controller Design using Single Linear Nominal Plant and each Linear Subsystem as Nominal Plant - Controller Design using Discrete T-S Fuzzy System.

TEXTBOOKS:

Behera L., Kar I., "Intelligent Systems and Control: Principles and Applications", Oxford University Press, 2009.

REFERENCES:

1. *Gopal M., "Digital Control and State Variable Methods", Tata McGraw Hill, third Edition, 2008.*

2. *Zi-Xing C., "Intelligent Control: Principles, Techniques and Applications", World Scientific Publishing Co. Pvt. Ltd., 1997.*
3. *Jang J. S. R., Sun C. T., Mizutzni E., "Neuro-Fuzzy and Soft Computing", Prentice Hall India Private Limited, 2002.*
4. *Spooner J. T., Maggiore M., Ordóñez R. and Passino K. M., "Stable Adaptive Control and Estimation for Nonlinear Systems: Neural and Fuzzy Approximator Techniques", John Wiley and Sons, 2002*

15EIE336 SENSORS AND SIGNAL CONDITIONING 3 0 0 3

Unit 1

Resistive Sensors: Strain Gauge - Thermistors, Magneto Resistors - Light Dependent Resistors - Resistive Gas Sensors - Signal Conditioning for Resistive Sensors: Measurement of Resistance, Voltage Dividers, Wheatstone Bridge. Balance and Deflection Measurements, Sensor Bridge Calibration and Compensation Instrumentation Amplifiers, Interference Types and Reduction.

Unit 2

Electromagnetic Sensors: Capacitive Sensors - Inductive Sensors - Superconducting Quantum Interference Devices - Flux-Gate Sensors - Signal Conditioning for Reactance Variation Sensors: Problems and Alternatives - AC Bridges, Carrier Amplifiers - Application to the LVDT - Oscillators - Resolver-to Digital and Digital-to-Resolve Converters.

Unit 3

Self-Generating Sensors: Thermoelectric Piezoelectric, Pyro Electric and Photovoltaic Sensors - Signal Conditioning for Self-Generating Sensors: Chopper and Low-Drift Amplifiers - Offset and Drifts Amplifiers - Electrometer Amplifiers - Charge Amplifiers - Noise in Amplifiers.

TEXTBOOK:

Pallás-Areny R, Webster J G, "Sensors and Signal Conditioning", John Wiley and Sons, Second Ed., 2000.

REFERENCES:

1. *Wilson J, "Sensor Technology Handbook", Newnes, 2004.*
2. *Patranabis D, " Sensors and Transducers", Tata McGraw-Hill, 2003*
3. *Doeblin E O, "Measurement System: Applications and Design", McGraw Hill Publications, 2010.*

15EIE337 VIRTUAL INSTRUMENTATION 3 0 0 3

Unit 1

Introduction: Historical Perspective - Advantages - Virtual Instrumentation Software

- Front Panel, Block Diagram, Controls and Functions Palettes - Controls, Indicators, Terminals and Constants - Architecture of a Virtual Instrument - Data Flow Techniques - Graphical Programming in Data Flow – Comparison With Conventional Programming - Embedded, Real Time and Industrial Control Systems - OPC, SCADA/HMI. Sampling Fundamentals: Review of Quantization in Amplitude and Time Axes - Sample and Hold - Sampling Theorem - ADC and DAC - Digital I/O - Counter/Timer Operation.

Unit 2

Data Acquisition Basics: Introduction to Data Acquisition - Data Acquisition Boards - Typical on Board DAQ Card - Resolution and Sampling Frequency - Multiplexing of Analog Inputs - Single-Ended and Differential Inputs - Different Strategies for Sampling of Multi-Channel Analog Inputs - Concept of Universal DAQ Card - Use of Timer-Counter and Analog Outputs on the Universal DAQ Card - Driver Software - Calibration - Accuracy - Resolution - Interface Requirements - Data Analysis.

Unit 3

Instrument Control: Instrument Control Systems - Instrument Control Software and Hardware - Instrument Drivers - Serial Interface RS232, RS422, RS485 - IEEE488 (GPIB) Interfaces - VISA - VISA Compatible Instruments - USB Standards - ISO-OSI Model for Serial Bus - Introduction to Bus Protocols of MOD Bus and CAN Bus. Applications of Virtual Instrumentation: Digitizers - Oscilloscopes - Image/Sound Acquisition and Processing - Motion Control - Simple Temperature Indicator - ON/OFF Controller - PID Controller - Simulation of a Simple Second Order System.

TEXTBOOKS:

1. *James K, "PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control", Newnes, 2000.*
2. *Jerome J, "Virtual Instrumentation using LabVIEW," Prentice Hall of India Pvt Ltd, 2010.*

REFERENCES:

1. *Travis J & King J, "LabVIEW for everyone: Graphical Programming Made Easy and Fun", Pearson Education, Third edition, 2007.*
2. *National Instruments LabVIEW Manual.*

15EIE381 SIGNAL PROCESSING LAB. 0 0 2 1

1. Generation of sequences
2. Basic operations on signals
3. Properties of system
4. Convolution
5. Interconnection of systems
6. Frequency response of LTI Systems
7. Frequency domain representation

8. Time shifting property - DTFS
9. LTI System - analysis
10. Sampling of analog signals and study of aliasing
11. Computation of DFT using direct /linear transformation method
12. Properties of DFT
13. Computation of 2-N point DFT of a real sequence by using an N point DFT just once.
14. Linear filtering using Overlap add / save method
15. Design of FIR filter (different windowing technique)
16. Design of IIR Butterworth filter
17. Applications of DSP - a few case studies

15EIE385 PROCESS CONTROL LAB. 0 0 2 1

1. Experiments with process control simulator
2. Experiments with interacting and non interacting systems
3. Experiments on Multi Process Trainer
4. Experiments on Pressure Control Trainer
5. Experiments with control valves
6. Experiments on Flow Control Trainer
7. Study of I/P and P/I converter
8. Experiments on Level Control Trainer
9. Experiments on DC motor Control Trainer
10. Experiments on AC motor Control Trainer

15EIE386 OPEN LAB. 0 1 2 2

The objective of this lab course is to provide opportunities for hands-on experience in the hardware domain to design develop and realize prototype electronic systems.

15EIE390 / 15EIE490 LIVE-IN-LAB. 3 cr

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or rural sites during the vacations (after fourth semester or sixth semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth or seventh semester. The objectives and projected outcome of the project should be reviewed and approved by the Dept. chairperson and a faculty assigned as the project guide. On completion of the project, the student shall submit a detailed project report. The report shall be evaluated and the students shall appear for a viva-voce test on the project.

15EIE401 DATA ACQUISITION AND COMMUNICATION 3 1 0 4

(Pre-requisite: 15ECE304 Microprocessor and Microcontroller)

Unit 1

Fundamentals of data acquisition: Transducers and sensors – Field wiring and communications cabling – Signal conditioning – Data acquisition hardware – Data acquisition software - Host computer.

Data acquisition and control system configuration: Computer plug – in I/O – Distributed I/O - Stand-alone or distributed loggers / controllers - IEEE488 (GPIB) remotely programmable instruments - RS232 and RS485 communication.

Data acquisition boards: A/D Boards - Single ended vs differential signals – Resolution – dynamic range and accuracy of A/D boards –Sampling techniques – Speed vs throughput - D/A boards – Digital / O boards – Interfacing digital inputs / outputs – Counter / timer /O boards.

Unit 2

Introduction to Communication Systems: Analog and Digital – Bandwidth – Noise–sources and SNR. Modulation – Necessity – Analog and Digital Modulation Amplitude Modulation – Theory – Modulation Index – power and band width considerations – Modulation schemes – DSBSC – SC – SSB – VSB – Applications.

Unit 3

Frequency Modulation: Theory - FM and Phase Modulation – Frequency spectrum. Introduction to PWM - PPM and PCM Introduction to Digital Communication – FSK - PSK.

TEXTBOOKS:

1. *James K, "PC interfacing and data acquisition techniques for measurement, instrumentation and control," Oxford, Newnes, 2000.*
2. *Kennedy G, Davis B, and Prasanna S R M, "Electronic Communication Systems," New Delhi, Tata McGraw-Hill, fifth edition, 2011.*

REFERENCES:

1. *Park J and Mackay S, "Practical data acquisition for instrumentation and control systems", Boston, Elsevier, 2003.*
2. *Taylor H R, "Data Acquisition for Sensor Systems," Boston, MA, Springer US, 1997.*
3. *Haykin S and Moher M, "Introduction to Analog and Digital Communications". New Delhi, Wiley India Pvt. Ltd, second Edition, 2012.*

15EIE402 INDUSTRIAL AUTOMATION 3 1 0 4

(Pre-requisite: 15EIE312 Process Control)

Unit 1

Introduction to Industrial Automation (SCADA, DCS, PLC, Field bus) Programmable Logic Controllers (PLCs): An Overview – PLC Hardware Components – Fundamentals of Logic – Basics of PLC Programming (SLC500) – Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs – Timers – Counters – Program Control Instructions (MCR, JMP, SBR only).

Unit 2

Network data communication, Introduction to computer networks: Network Categories – Topologies - IEEE802 Standards Transmission Media: Coaxial Cable – Fiber Optics – ISO / OSI Model – TCP/IP model. Data Link Layer: Error Detection and Correction – Parity – LRC – CRC – Hamming Code - flow Control – media access sub layer: channel allocation protocols – Ethernet – Wireless LAN Network Layer: Internetworks - Packet Switching and Datagram approach - IP addressing methods – Subnetting - Routing.

Unit 3

Transport Layer: Duties of transport layer - Multiplexing, Sockets – User Datagram Protocol (UDP) – Transmission Control Protocol (TCP) – Application Layer: Domain Name Space (DNS) – HTTP - WWW Fieldbuses: Classification of fieldbuses – HART – FOUNDATION FIELD BUS.

Distributed Control Systems (DCS) (only concept): Introduction – history and concept of DCS – distributed vs centralized – Advantages of DCS – explanation of a typical commercially available DCS.

TEXTBOOKS:

1. *Frank D.P., "Programmable Logic Controllers", Tata McGraw-Hill Publishing Company Limited, third Edition. 2005.*
2. *Andrew S. Tanenbaum, "Computer Networks", PHI, fifth edition, 2011.*

REFERENCES:

1. *John. W. Webb and Ronald A Reis, "Programmable Logic Controllers - Principles and Applications", Prentice Hall of India Private Limited, fifth edition, 2009.*
2. *Mathivanan. N. "PC-Based Instrumentation Concepts and practice", Prentice Hall of India Private Limited, 2007.*
3. *Anand M. M. S, "Electronic Instruments and Instrumentation Technology", Prentice Hall of India Private Limited, 2004.*
4. *Surekha Bhanot, "Process Control - Principles & Applications", Oxford University Press, 2008.*

15EIE403 POWERELECTRONIC DEVICES AND CIRCUITS 3 1 0 4

(Pre-requisite: 15ECE211 Electronic Circuits)

Unit 1

Characteristics of power semiconductor switches – power diodes – power transistors – triac – SCR – two transistor model of SCR –diode rectifiers – gating and protection circuit – Turn on circuits for SCR – commutation – GTO – power MOSFET and IGBT – construction – principle and working.

Unit 2

Phase controlled converters: Single phase semi and full converters – three phase semi and full converters – power factor improvement by PWM control – effects of source inductance. Dual converter – AC and DC chopper – DC to DC converters – buck-boost and buck-boost.

Unit 3

AC Voltage Controllers: Principle of ON-OFF control and phase control – single / three phase controllers – PWM AC voltage controller – cyclo-converters. Inverters: Voltage and current source inverters – PWM inverter.

TEXTBOOKS:

1. *Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics, Converters, Applications and Design", John Wiley & Sons, third Edition, 2003.*
2. *Muhammad H. Rashid, "Power Electronics-Circuits, Devices and Applications", Pearson Education Inc., third Edition, 2004.*

REFERENCES:

1. *Joseph Vithayathil, "Power Electronics", McGraw-Hill, second Edition, 2010.*
2. *A. M. Trzynadlowski, "Introduction to Modern Power Electronics", John Wiley & Sons, second Edition, 2010.*
3. *Daniel W Hart, "Introduction to Power Electronics", third Edition, 2004.*
4. *M. D Singh, K. B Khanchandani, "Power Electronics", Tata McGraw-Hill, second Edition, 2006.*

15EIE481 INDUSTRIAL AUTOMATION LAB. 0 0 2 1

Experiments on industrial automation systems like DCS, PLC, SCADA and data acquisition using LABVIEW and MATLAB with data acquisition cards

15EIE495 PROJECT PHASE I 2 cr

- Design development and realization of selected problems and solutions based on EIE domain.
- Review and analysis of state of the arttechnology based research and development.

- Publication-oriented academic research.
- Industry-oriented problems and its solutions.
- Demonstration of working prototype model.
- Preparation of project report in prescribed format.

15EIE499 PROJECT PHASE II 10 cr

- Design development and realization of selected problems and solutions based on EIE domain.
- Review and analysis of state of the arttechnology based research and development.
- Publication-oriented academic research.
- Industry-oriented problems and its solutions.
- Demonstration of working prototype model.
- Preparation of project report in prescribed format.
- Publications in conference / journal approved by the department as the outcome of the project.

15ENG111 COMMUNICATIVE ENGLISH 2 0 2 3

OBJECTIVES: *To make the students communicate their thoughts, opinions, and ideas freely and naturally; to make them understand the different styles in communication; to make the students understand the aesthetics of reading and writing; to bring in a spirit of enquiry; to motivate critical thinking and analysis; to help them ruminate on human values.*

Unit 1
Reading: Different styles of communication – Reading Comprehension - critical thinking and analysis – Note-making – Any two pieces from the text.

Unit 2
Writing: Prewriting techniques - Kinds of paragraphs - basics of continuous writing.

Grammar & Usage: Parts of Speech, Tenses, Concord, Phrasal Verbs, Modal Auxiliaries, Modifiers (Workbook) - Any two pieces from the text.

Unit 3
Practical sessions (Listening & Speaking): Introduction to English pronunciation including minimal pairs and word stress – differences between British and American English – Listening comprehension and Note-taking - Any two pieces from the text.

Activities: Short speeches, seminars, quizzes, language games, debates, and discussions, Book Reviews, etc.

Text: *Language through Reading: Compilation by Amrita University for internal circulation*

Poems:
i. The Poplar Field by William Cowper
ii. Telephone Conversation by Wole Soyinka
Prose:
i. Higher Mathematics by R. K. Narayan
ii. Wings of Fire by Abdul Kalam (Part III.11)
Short Stories:
i. Best Investment I Ever Made by A. J. Cronin
ii. Death of an Indian by Krishna Charan Das

1.Language through Practice: Compilation by Amrita University for internal circulation

15ENG230 BUSINESS COMMUNICATION 1 0 2 2

OBJECTIVES: *To introduce business vocabulary; to introduce business style in writing and speaking; to expose students to the cross-cultural aspects in a globalised world; to introduce the students to the art of persuasion and negotiation in business contexts.*

Unit 1
Business Vocabulary - Writing: Drafting Notices, Agenda, and Minutes - Reading: Business news, Business articles.

Unit 2
Writing: Style and vocabulary - Business Memorandum, letters, Press Releases, reports – proposals – Speaking: Conversational practice, telephonic conversations, addressing a gathering, conducting meetings.

Unit 3
Active Listening: Pronunciation – information gathering and reporting - Speaking: Cross-Cultural Issues, Group Dynamics, negotiation& persuasion techniques.

Activities
Case studies & role-plays.

BOOKS RECOMMENDED:

1. *Jones, Leo & Richard Alexander. New International Business English. CUP. 2003.*
2. *Horner, David & Peter Strutt. Words at Work. CUP. 1996.*
3. *Levi, Daniel. Group Dynamics for Teams. 3 ed. Sage Publications India Pvt. Ltd. New Delhi, 2011.*
4. *Owen, Roger. BBC Business English. BBC. 1996.*
5. *Henderson, Greta Lafollette & Price R Voiles. Business English Essentials. 7th Edition. Glencoe / McGraw Hill.*
6. *Sweeney, Simon. Communicating in Business. CUP. 2000.*

15ENG231 INDIAN THOUGHT THROUGH ENGLISH 1 0 2 2

OBJECTIVES: *To expose the students to the greatness of Indian Thought in English; to develop a sense of appreciation for the lofty Indian Thought; to develop an understanding of the eclectic Indian psyche; to develop an understanding about the societal changes in the recent past.*

Unit 1 Poems

Rabindranath Tagore's Gitanjali (1-10); Nizzim Ezekiel's Enterprise; A.K. Ramanujam's Small-Scale Reflections on a Great House.

Unit 2 Prose

Khushwant Singh's The Portrait of a Lady; Jhumpa Lahiri's Short Story - Interpreter of Maladies.

Unit 3 Drama and Speech

Vijay Tendulkar's Silence, the Court is in Session; Motivational speeches by Jawaharlal Nehru/ S. Radhakrishnan / A.P. J. Abdul Kalam's My Vision for India etc. (any speech).

REFERENCES:

1. *Lahiri, Jhumpa. Interpreter of Maladies, Harper Collins Publications, 2000.*
2. *Ramanujan A. K. ed. K.M. George, Modern Indian Literature: An Anthology, Vol. I, Sahitya Akademi, 1992.*
3. *Singh, Khushwant. The Portrait of a Lady: Collected Stories, Penguin, 2009.*
4. *Tagore, Rabindranath. Gitanjali, Penguin Books India Pvt. Ltd, 2011.*
5. *Tendulkar, Vijay. Five Plays, Oxford University Press, 1996.*

15ENG232 INSIGHTS INTO LIFE THROUGH ENGLISH LITERATURE 1 0 2 2

OBJECTIVES: *To expose the students to different genres of Literature; to hone reading skills; to provide deeper critical and literary insights; to enhance creative thinking; to promote aesthetic sense.*

Unit 1 Poems

1. W. H. Auden: Refugee Blues; 2. A. K. Ramanujan: Obituary; 3. William Blake: The LittleBlack Boy; 4. Gieve Patel: Grandparents at a Family Get–together.

Unit 2 Short Stories

1. Chinua Achebe: Marriage is a Private Affair; 2. Ruskin Bond: The Thief; 3. Isai Tobolsky: Not Just Oranges; 4. K A Abbas: The Refugee

Unit 3 Prose

1. A G Gardiner: On The Philosophy Of Hats;2. Robert Lynd: Mispronunciation

Practicals:

Role plays: The Proposal, Chekov / Remember Ceaser, Gordon Daviot / Final Solutions, Mahesh Dattani , Book reviews, Movie reviews.

SUGGESTED READING:The Old Man and the Sea, Hemingway / Any one of the novels of R. K. Narayan, etc.

15ENG233 TECHNICAL COMMUNICATION 1 0 2 2

OBJECTIVES: *To introduce the students to the elements of technical style; to introduce the basic elements of formal correspondence; to introduce technical paper writing skills and methods of documentation; to improve oral presentation skills in formal contexts.*

Unit 1

Mechanics of writing: Grammar rules – punctuation - spelling rules - tone and style - graphical Representation.

Unit 2

Different kinds of written documents: Definitions – descriptions – instructions – recommendations - manuals - reports – proposals; Formal Correspondence: Letter Writing including job applications with Resume.

Unit 3

Technical paper writing: Library research skills - documentation style - document editing – proof reading – formatting.

Practice in oral communication and Technical presentations

REFERENCESI:

1. *Hirsh, Herbert. L "Essential Communication Strategies for Scientists, Engineers and Technology Professionals". II Edition. New York: IEEE press, 2002*
2. *Anderson, Paul. V. "Technical Communication: A Reader-Centred Approach". V Edition. Harcourt Brace College Publication, 2003*
3. *Strunk, William Jr. and White. E B. "The Elements of Style" New York. Alliyan & Bacon, 1999.*
4. *Riordan, G. Daniel and Pauley E. Steven. "Technical Report Writing Today" VIII Edition (Indian Adaptation). New Delhi: Biztantra, 2004.*

15ENG234 INDIAN SHORT STORIES IN ENGLISH 1 0 2 2

OBJECTIVES: *To help the students learn the fine art of story writing; to help them learn the techniques of story telling; to help them study fiction relating it to the socio- cultural aspects of*

the age; to familiarize them with different strategies of reading short stories; to make them familiar with the morals and values held in high esteem by the ideals of Indianness.

Unit 1

Introduction: Differences between novel and short stories – origin and development of short stories - Rabindranath Tagore: Kabuliwallah; Mulk Raj Anand: The Gold Watch.

Unit 2

R. K. Narayan: Sweets for Angels; K. A. Abbas: The Refugee; Khushwant Singh: The Mark of Vishnu.

Unit 3

Masti Venkatesha Iyengar: The Curds-Seller; Manohar Malgonkar: Upper Division Love; Romila Thapar: The Spell; Premchand: The Voice of God.

TEXT:

M. G. Narasimha Murthy (ed), Famous Indian Stories. Hyderabad: Orient Black Swan, 2014

REFERENCE;

Mohan Ramanan (Ed), English and the Indian Short Story: Essays in Criticism, Hyderabad, Orient BlackSwan, 2000.

15ENV300 ENVIRONMENTAL SCIENCE AND SUSTAINABILITY 3 0 0 3

Unit 1

State of Environment and Unsustainability, Need for Sustainable Development, Traditional conservation systems in India, People in Environment, Need for an attitudinal change and ethics, Need for Environmental Education, Overview of International Treaties and Conventions, Overview of Legal and Regulatory Frameworks.

Environment: Abiotic and biotic factors, Segments of the Environment, Biogeochemical Cycles, Ecosystems (associations, community adaptations, ecological succession, Food webs, Food chain, ecological pyramids), Types of Ecosystems – Terrestrial ecosystems, Ecosystem Services, Economic value of ecosystem services, Threats to ecosystems and conservation strategies.

Biodiversity: Species, Genetic & Ecosystem Diversity, Origin of life and significance of biodiversity, Value of Biodiversity, Biodiversity at Global, National and Local Levels, India as a Mega-Diversity Nation (Hotspots) & Protected Area Network, Community Biodiversity Registers.Threats to Biodiversity, Red Data book, Rare, Endangered and Endemic Species of India.Conservation of Biodiversity.People's action.

Impacts, causes, effects, control measures, international, legal and regulatory frameworks of: Climate Change, Ozone depletion, Air pollution, Water pollution, Noise pollution, Soil/land degradation/pollution

Unit 2

Linear vs. cyclical resource management systems, need for systems thinking and design of cyclical systems, circular economy, industrial ecology, green technology. Specifically apply these concepts to: Water Resources, Energy Resources, Food Resources, Land & Forests, Waste management.

Discuss the interrelation of environmental issues with social issues such as: Population, Illiteracy, Poverty, Gender equality, Class discrimination, Social impacts of development on the poor and tribal communities, Conservation movements:people's movements and activism, Indigenous knowledge systems and traditions of conservation.

Unit 3

Common goods and public goods, natural capital / tragedy of commons, Cost benefit analysis of development projects, Environment Impact Assessment(EIA), Environment Management Plan (EMP), Green business, Eco-labeling, Problems and solutions with case studies.

Global and national state of housing and shelter, Urbanization, Effects of unplanned development case studies, Impacts of the building and road construction industry on the environment, Eco-homes /Green buildings, Sustainable communities, Sustainable Cities.

Ethical issues related to resource consumption, Intergenerational ethics, Need for investigation and resolution of the root cause of unsustainability, Traditional value systems of India, Significance of holistic value-based education for true sustainability.

TEXTBOOKS / REFERENCES:

1. *R. Rajagopalan, Environmental Studies: From Crisis to Cure. Oxford University Press, 2011, 358 pages. ISBN: 9780198072089.*
2. *Daniel D. Chiras, Environmental Science. Jones & Bartlett Publishers, 01-Feb-2012, 669 pages. ISBN: 9781449645311.*
3. *Andy Jones, Michel Pimbert and Janice Jiggins, 2011. Virtuous Circles: Values, Systems, Sustainability. IIED and IUCN CEESP, London. URL: http://pubs.iied.org/pdfs/G03177.pdf*
4. *Annenberg Learner, The Habitable Planet, Annenberg Foundation 2015. URL: http://www.learner.org/courses/envsci/unit/pdfs/textbook.pdf.*

15FRE230 PROFICIENCY IN FRENCH LANGUAGE (LOWER) 1 0 2 2

Unit 1 Population - Identity
How to introduce yourself (name, age, address, profession, nationality); Numbers; How to ask questions;

Grammar – Pronouns - subjects; Regular verbs of 1st group (er) in the present; Être (to be) and avoir (to have) in the present; Interrogative sentence; Gender of adjectives.

Unit 2 The suburbs - At the train station
Introduce someone; Buy a train ticket or a cinema ticket; Ask for information; Official time; Ask for a price; The city (church, town hall, post office…)

Grammar – Pronouns - subjects (continuation); Gender of adjectives (continuation); Plural of nouns and adjectives; Definite and indefinite articles; Interrogative adjectives; I would like (Je voudrais).

Unit 3 Paris and the districts - Looking for a room
Locate a room and indicate the way; Make an appointment; Give a price; Ordinal numbers; Usual time; Ask for the time.

Grammar - Imperative mode; Contracted articles (au, du, des); negation.

TEXTBOOK:
Metro St Michel - Publisher: CLE international

15FRE231 PROFICIENCY IN FRENCH LANGUAGE (HIGHER) 1 0 2 2

Unit 1 The first room of a student
A party to celebrate the 1st room; Description of a room; furniture; Locate objects: prepositions (devant, derrière, dans…), Read advertisement; Appreciation (I like, I prefer,).

Grammar - Perfect past tense with avoir; Possessive adjectives (mon, ton, son…); Demonstrative adjectives (ce, cet, cette); Yes (oui, si).

Unit 2 Small jobs
Conversation on the phone; Give Time indications; Answer a job offer; Describe a job; Suggest a meeting time.

Grammar - Perfect past tense with être and avoir (continuation); Possessive adjectives (notre, votre, leur); Prepositions (à, pour, avec ...); Pronoun as direct object (le, la, l', les).

Unit 3 University Restaurant
Inquiry;Express an opinion; Ask questions (continuation); Food, meals, taste, preferences; Nutrition, diet, choose a menu or diet, Expression of quantities (beaucoup, peu).

Grammar - Partitif (expressing quantity) (du, de la, pas de.…); Comparison (plus ...que, moins….que, autant …que); Interrogation (continuation), inversion, Est-ce que, qu'est-ce que?.

TEXTBOOK:
Metro St Michel - Publisher: CLE International

15GER230 GERMAN FOR BEGINNERS I 1 0 2 2

Unit 1
Greetings; Introducing one-self (formal and informal context), saying their name, origin, living place, occupation.

Numbers 1-100; Saying the telephone number.

Countries and Languages.

Grammar: Structure – W - Questions and Yes/No questions and statements, personal pronouns, verb conjugations. Articles.
Vocabulary: Professions.

Unit 2
Giving the personal details. Name, age, marital status, year of birth, place of birth, etc.

Numbers till 1000. Saying a year.
Alphabets – spelling a word.

Filling up an application form; In the restaurant – making an order.

Grammar: Definite, indefinite and negative article in nominative. Accusative: indefinite and negative Article

Vocabulary: Food items

Unit 3
Numbers above 1000. Orientation in Shopping plazas: asking the price, where do I find what, saying the opinion.

Grammar: Accusative – definite article. Adjectives and plural forms.

Vocabulary: Furniture and currencies.

15GER231 GERMAN FOR BEGINNERS II 1 0 2 2

Unit 1
Shopping and orientation in supermarket; Conversation between the customer and salesman; Where one finds what in supermarket; Asking for requests and suggestions.

Grammar: Dative of personal pronouns. Imperative form.

Vocabulary: Consumables and measurements;

Unit 2
Appointments; Work and leisure time activities; Time, weekdays, months and seasons; saying the date; fixing up an appointment.

Grammar: Model verbs; Prepositions with time and place; Ordinal numbers.
Vocabulary: Leisure activities, weekdays, months and seasons.

Unit 3
Family and household; Family and relations; household and daily routine.

Grammar: Possessive articles; Divisible and indivisible verbs.

Vocabulary: Family circle; Household articles.

15GER232 PROFICIENCY IN GERMAN LANGUAGE (LOWER) 1 0 2 2

To have an elementary exposure to German language; specifically
1. to have some ability to understand simple spoken German, and to be able to speak it so as to be able to carry on life in Germany without much difficulty (to be able to do shopping, etc.);
2. to be able to understand simple texts, and simple forms of written communication;
3. to have a basic knowledge of German grammar;
4. to acquire a basic vocabulary of 500 words;
5. to be able to translate simple letters with the use of a dictionary; and
6. to have some familiarity with the German life and culture.

(This will not be covered as part of the regular classroom teaching; this is to be acquired by self-study.)

Some useful websites will be given.

15GER233 PROFICIENCY IN GERMAN LANGUAGE (HIGHER) 1 0 2 2

The basic vocabulary and grammar learned in the earlier course is mostly still passive knowledge. The endeavour of this course is to activate this knowledge and develop the skill of communication.
Topics are: Airport, railway station, travelling; shopping; invitations, meals, meeting people; around the house; the human body; colours; professions.

Past and future tenses will be introduced. Applying genitive, dative and accusative.

Some German culture. Films.

15HIN101 HINDI I 1 0 2 2

OBJECTIVES: *To teach Hindi for effective communication in different spheres of life - Social context, Education, governance, Media, Business, Profession and Mass communication.*

Unit 1
Introduction to Hindi Language, National Language, Official Language, link Language etc. Introduction to Hindi language, Devanagari script and Hindi alphabet.

Shabda Bhed, Roopanthar ki Drishti se - Bhasha – Paribhasha aur Bhed - Sangya - Paribhasha Aur Bhed- Sangya ke Roopanthar - kriya.

Unit 2
Common errors and error corrections in Parts of Speech with emphasis on use of pronouns, Adjective and verb in different tenses – Special usage of adverbs, changing voice and conjunctions in sentences, gender& number - General vocabulary for conversations in given context – understanding proper pronunciation – Conversations, Interviews, Short speeches.

Unit 3
Poems – Kabir 1st 8 Dohas, Surdas 1st 1 Pada; Tulsidas 1st 1 Pada; Meera 1st 1 Pada

Unit 4
Letter writing – personal and Formal –Translation from English to Hindi.

Unit 5
Kahani – Premchand: Kafan, Abhilasha, Vidroh, Poos ki rath, Juloos.

BOOKS:

1. Prem Chand Ki Srvashrestha Kahaniyam: Prem Chand; Diamond Pub Ltd. New Delhi

2. *Vyavaharik Hindi Vyakaran ,Anuvad thaha Rachana : Dr. H. Parameswaran, Radhakrishna publishing House,New Delhi*
3. *Kamtha Prasad Guru : Hindi Vyakaran, Best Book pub House, New Delhi*
4. *Poetry : Kavya Ras-Ed: T.V. Basker- Pachouri Press; Mathura*

15HIN111 HINDI II 1 0 2 2

OBJECTIVES: *Appreciation and assimilation of Hindi Literature both drisya & shravya using the best specimens provided as anthology.*

Unit 1
Kavya Tarang; Dhumil ke Anthim Kavitha [Poet-Dhumil]; Dhabba [Poet-Kedarnath Singh]; Proxy [Poet-Venugopal]; Vakth [Poet-Arun Kamal]; Maachis [Poet-Suneeta Jain].

Unit 2
Communicative Hindi - Moukhik Abhivyakthi

Unit 3
Audio-Visual – Media in Hindi – Movies like Tare Zameen par, Paa, Black etc., appreciation and evaluation. News reading and presentations in Radio and TV channels in Hindi.

Unit 4
Gadya Manjusha – Budhapa, Kheesa, Sadachar ka Thavis

Unit 5
Translation: Theory and Practice - Letter writing: Formal and Personal – Introduction to Hindi Software.

BOOKS:
1. *Kavay Tarang: Dr. Niranjan, Jawahar Pusthakalay, Mathura.*
2. *Gadya Manjusha: Editor: Govind, Jawahar Pusthakalay, Mathura*

15HUM230 EMOTIONAL INTELLIGENCE 2 0 0 2

Unit 1
Emotional Intelligence: Concept of Emotional Intelligence, Understanding the history and origin of Emotional Intelligence, Contributors to Emotional Intelligence, Science of Emotional Intelligence, EQ and IQ, Scope of Emotional Intelligence.

Unit 2
Components of Emotional Intelligence: Self-awareness, Self-regulation, Motivation,

Empathy, Social skills. Emotional Intelligence Competencies, Elements of Emotional Intelligence, Models of Emotional Intelligence: The Ability-based Model, The Trait Model of Emotional Intelligence, Mixed Models of Emotional Intelligence.

Unit 3
Emotional Intelligence at Work place: Importance of Emotional Intelligence at Work place? Cost – savings of Emotional Intelligence, Emotionally Intelligent Leaders, Case Studies Measuring Emotional Intelligence: Emotionally Intelligence Tests, Research on Emotional Intelligence, Developing Emotional Intelligence.

REFERENCES:
1. *Daniel Goleman (1996). Emotional Intelligence- Why it can Matter More than IQ. Bantam Doubleday Dell Publishing Group*
2. *Daniel Goleman (2000). Working with Emotional Intelligence. Bantam Doubleday Dell Publishing Group*
3. *Liz Wilson, Stephen Neale &Lisa Spencer-Arnell (2012). Emotional Intelligence Coaching. Kogan Page India Private Limited*

15HUM231 GLIMPSES INTO THE INDIAN MIND: 2 0 0 2
THE GROWTH OF MODERN INDIA

Unit 1
Introduction
General Introduction; 'His + Story' or 'History' ?; The concepts of 'nation', 'national identity' and 'nationalism'; Texts and Textualities: Comparative Perspectives.

Unit 2
Selected writings / selections from the complete works of the following authors will be taken up for study in a chronological order:
Raja Ram Mohan Roy; Dayananda Saraswati; Bal Gangadhar Tilak; Rabindranath Tagore;

Unit 3
Selected writings / selections from the complete works of the following authors will be taken up for study in a chronological order:
Swami Vivekananda; Sri Aurobindo; Ananda K. Coomaraswamy; Sister Nivedita; Mahatma Gandhi; Jawaharlal Nehru; B.R. Ambedkar; Sri Chandrasekharendra Saraswati, the Paramacharya of Kanchi; Dharampal; Raja Rao; V.S. Naipaul.

Conclusion.

REFERENCES:
1. *Tilak, Bal Gangadhar.The Orion / Arctic Home in the Vedas.*

2. Tagore, Rabindranath. The History of Bharatavarsha / On Nationalism / Greater India.
3. Vivekananda, Swami. "Address at the Parliament of Religions" / "The Future of India" / "In Defence of Hinduism" from Selections from the Complete Works of Swami Vivekananda.
4. Aurobindo, Sri. The Renaissance in India / On Nationalism.
5. Coomaraswamy, Ananda K. Essays in Indian Idealism (any one essay) / Dance of Shiva.
6. Nivedita, Sister. "Noblesse Oblige: A Study of Indian Caste" / "The Eastern Mother" from The Web of Indian Life.
7. Gandhi, Mahatma. Hind Swaraj.
8. Nehru, Jawaharlal. "The Quest" from Discovery of India.
9. Ambedkar, B.R. "Buddha and His Dhamma" from Collected Works.
10. Saraswati, Chandrasekharendra. "The Sastras and Modern Life" from The Hindu Dharma.
11. Dharampal. Bharatiya Chitta, Manas and Kala / Understanding Gandhi.
12. Naipaul, V.S. India: A Wounded Civilization / India: A Million Mutinies Now.

15HUM232 GLIMPSES OF ETERNAL INDIA 2 0 0 2

Unit 1

Introduction

A peep into India's glorious past

Ancient India – the vedas, the vedic society and the Sanatana Dharma – rajamandala and the Cakravartins – Ramarajya – Yudhisthira's ramarajya; Sarasvati - Sindhu Civilization and the myth of the Aryan Invasion; Classical India – Dharma as the bedrock of Indian society – Vaidika Brahmanya Dharma and the rise of Jainism and Buddhism – the sixteen Mahajanapadas and the beginning of Magadhan paramountcy – Kautilya and his Arthasastra – Chandragupta Maurya and the rise of the Mauryan empire – Gupta dynasty Indian art and architecture – classical sanskrit literature – Harsavardhana; Trade and commerce in classical and medieval India and the story of Indian supremacy in the Indian ocean region; The coming of Islam – dismantling of the traditional Indian polity – the Mughal empire – Vijayanagara samrajya and days of Maratha supremacy.

Unit 2

India's contribution to the world: spirituality, philosophy and sciences

Indian Philosophy – the orthodox (Vaidika) and the heterodox (atheistic) schools; Ramayana and Mahabharata; Bhagavad Gita; Saints and sages of India; Ancient Indian medicine: towards an unbiased perspective; Ancient Indian mathematics; Ancient Indian astronomy; Ancient Indian science and technology.

The arrival of Europeans, British paramountcy and colonization

What attracted the rest of the world to India?; India on the eve of the arrival of European merchants; The story of colonization and the havoc it wrecked on Indian culture and civilization; Macaulay and the start of the distortion of Indian education

and history; Indian economy – before and after colonization: a brief survey; The emergence of modern India.

Unit 3

Women in Indian society

The role and position of women in Hindu civilization; Gleanings from the Vedas, Brihadarnyaka Upanishad, Saptasati Devi Mahatmyam, Ramayana, Mahabharata, Manusmriti, Kautilya's Arthasastra and Mrichchhakatikam of Sudraka; The role and position of Indian women vis-a-vis Islam and European cultures; The great women of India.

Modern India

The national movement for freedom and social emancipation; Swami Vivekananda, Sri Aurobindo, Rabindranath Tagore; Understanding Mahatma Gandhi; A new nation is born as a republic – the pangs of birth and growth; India since Independence – the saga of socio-political movements; Problems facing the nation today; Globalization and Indian Economy; Bharatavarsha today and the way ahead: Regeneration of Indian National Resources.

Conclusion

The Wonder that was India; The 'politics' and 'purpose' of studying India.

REFERENCES:

1. Parameswaran, S. The Golden Age of Indian Mathematics. Kochi: Swadeshi Science Movement.
2. Somayaji, D. A. A Critical Study of Ancient Hindu Astronomy. Dharwar: 1972.
3. Sen, S. N. & K. V. Sarma eds. A History of Indian Astronomy. New Delhi, 1985.
4. Rao, S. Balachandra. Indian Astronomy: An Introduction. Hyderabad: Universities Press, 2000.
5. Bose, D. M. et. al. A Concise History of Science in India. New Delhi: 1971.
6. Bajaj, Jitendra & M. D. Srinivas. Indian Economy and Polity. Chennai: Centre for Policy Studies.
7. Bajaj, Jitendra & M. D. Srinivas. Timeless India, Resurgent India. Chennai: Centre for Policy Studies.
8. Joshi, Murli Manohar. Science, Sustainability and Indian National Resurgence. Chennai: Centre for Policy Studies, 2008.
9. The Cultural Heritage of India. Kolkata: Ramakrishna Mission Institute of Culture.
10. Vivekananda, Swami. Selections from the Complete Works of Swami Vivekananda. Kolkata: Advaita Ashrama.
11. Mahadevan, T. M. P. Invitations to Indian Philosophy. Madras: University of Madras.
12. Hiriyanna, M. Outlines of Indian Philosophy. Motilal Banarsidass.
13. Tagore, Rabindranath. The History of Bharatavarsha / On Nationalism / Greater India.
14. Majumdar, R. C. et. al. An Advanced History of India. Macmillan.
15. Mahajan, V. D. India Since 1526. New Delhi: S. Chand & Company.

16. *Durant, Will. The Case for India. Bangalore: Strand Book Stall, 2008.*
17. *Aurobindo, Sri. The Indian Renaissance / India's Rebirth / On Nationalism.*
18. *Nivedita, Sister. The Web of Indian Life. Kolkata: Advaita Ashrama.*
19. *Durant, Will. The Story of Civilization. Volume 1 – Our Oriental Heritage. New York: Simon & Schuster.*
20. *Ranganathananda, Swami. Eternal Values for A Changing Society. Bombay: Bharatiya Vidya Bhavan.*
21. *Ranganathananda, Swami. Universal Message of the Bhagavad Gita. Kolkata: Advaita Ashrama.*
22. *Seturaman, V. S. Indian Aesthetics. Macmillan.*
23. *Coomaraswamy, Ananda K. The Dance of Shiva. New Delhi: Sagar Publications.*
24. *Coomaraswamy, Ananda K. Essays on Indian Idealism. New Delhi: Munshiram Manoharlal.*
25. *Danino, Michel. The Invasion That Never Was.*
26. *Kautilya. Arthasastra.*
27. *Altekar, A. S. State and Government in Ancient India. New Delhi: Motilal Banarsidass.*
28. *Altekar, A. S. The Position of Women in Hindu Civilization. New Delhi: Motilal Banarsidass.*
29. *Sircar, D. C. Studies in the Religious Life of Ancient and Medieval India. New Delhi: Motilal Banarsidass.*
30. *Sircar, D. C. Studies in the Political and Administrative Systems in Ancient and Medieval Times.New Delhi: Motilal Banarsidass.*
31. *Madhavananda, Swami & R. C. Majumdar eds. The Great Women of India. Kolkata: Advaita Ashrama.*
32. *Dutt, R. C. The Economic History of India. London, 1902.*
33. *Dharampal. Collected Works.*
34. *Dharampal. Archival Compilations (unpublished)*

15HUM233 GLIMPSES OF INDIAN ECONOMY AND POLITY 2 0 0 2

Unit 1

Introduction

General Introduction; Primitive man and his modes of exchange – barter system; Prehistoric and proto-historic polity and social organization.

Ancient India – up to 600 B.C.

Early India – the vedic society – the varnashramadharma – socio-political structure of the various institutions based on the four purusarthas; The structure of ancient Indian polity – Rajamandala and Cakravartins – Prajamandala; Socio-economic elements from the two great Epics – Ramayana and Mahabharata – the concept of the ideal King (Sri Rama) and the ideal state (Ramarajya) – Yudhisthira's ramarajya; Sarasvati - Sindhu civilization and India's trade links with other ancient civilizations; Towards chiefdoms and kingdoms – transformation of the polity: kingship – from gopati to bhupati; The mahajanapadas and the emergence of the srenis – states and cities of the Indo-Gangetic plain.

Unit 2

Classical India: 600B.C. – 1200 A.D.

The rise of Magadha, emergence of new religions – Buddhism and Jainism – and the resultant socio-economic impact; The emergence of the empire – the Mauryan Economy and Kautilya's Arthasastra; of Politics and trade – the rise of the Mercantile Community; Elements from the age of the Kushanas and the Great Guptas; India's maritime trade; Dharma at the bedrock of Indian polity – the concept of Digvijaya: dharma-vijaya, lobha-vijaya and asura-vijaya; Glimpses into the south Indian economies: political economies of the peninsula – Chalukyas, Rashtrakutas and Cholas

Medieval India: 1200 A.D. – 1720 A.D.

Advent of Islam – changes in the social institutions; Medieval India – agrarian economy, non-agricultural production and urban economy, currency system; Vijayanagara samrajya and maritime trade – the story of Indian supremacy in the Indian Ocean region; Aspects of Mughal administration and economy; The Maratha and other provincial economies.

Unit 3

Modern India: 1720 - 1947

the Indian market and economy before the arrival of the European traders; Colonisation and British supremacy (dismantling of everything that was 'traditional' or 'Indian') – British attitude towards Indian trade, commerce and economy and the resultant ruining of Indian economy and business – man-made famines – the signs of renaissance: banking and other business undertakings by the natives (the members of the early Tagore family, the merchants of Surat and Porbander, businessmen of Bombay, etc. may be referred to here) – the evolution of the modern banking system; Glimpses into British administration of India and administrative models; The National movement and nationalist undertakings in business and industry: the Tatas and the Birlas; Modern India: the growth of large-scale industry – irrigation and railways – money and credit – foreign trade; Towards partition – birth of two new nations – division of property; The writing of the Indian Constitution – India becomes a democratic republic – a new polity is in place.

Independent India – from 1947

India since Independence – the saga of socio-political movements; Indian economy since Independence – the fiscal system – the five year plans – liberalisation – the GATT and after; Globalisation and Indian economy; Impact of science and (new/ emerging) technology on Indian economy; Histories of select Indian business houses and business entrepreneurship.

Conclusion

REFERENCES:

1. *The Cultural Heritage of India. Kolkata: Ramakrishna Mission Institute of Culture.*
2. *Kautilya. Arthasastra.*
3. *Altekar, A. S. State and Government in Ancient India. New Delhi: Motilal Banarsidass.*
4. *Sircar, D. C. Studies in the Political and Administrative Systems in Ancient and Medieval Times. New Delhi: Motilal Banarsidass.*
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8. *Bajaj, Jitendra & M. D. Srinivas. Indian Economy and Polity. Chennai: Centre for Policy Studies.*
9. *Bajaj, Jitendra & M. D. Srinivas. Timeless India, Resurgent India. Chennai: Centre for Policy Studies.*
10. *Joshi, Murli Manohar. Science, Sustainability and Indian National Resurgence. Chennai: Centre for Policy Studies, 2008.*
11. *Tripathi, Dwijendra. The Oxford History of Indian Business. New Delhi: Oxford University Press, 2004.*
12. *McGuire, John, et al, eds. Evolution of World Economy, Precious Metals and India. New Delhi: Oxford University Press, 2001.*
13. *Tripathi, Dwijendra and Jyoti Jumani. The Concise Oxford History of Indian Business. New Delhi: Oxford University Press, 2007.*
14. *Kudaisya, Medha M. The Life and Times of G.D. Birla. New Delhi: Oxford University Press, 2003.*
15. *Raychaudhuri, Tapan and Irfan Haib, eds. The Cambridge Economic History of India. Volume 1. New Delhi: Orient Longman, 2004.*
16. *Kumar, Dharma, ed. The Cambridge Economic History of India. Volume 2. New Delhi: Orient Longman, 2005.*
17. *Sabavala, S. A. and R. M. Lala, eds. J. R. D. Tata: Keynote. New Delhi: Rupa & Co., 2004.*
18. *Mambro, Arvind ed. J. R. D. Tata: Letters. New Delhi: Rupa & Co., 2004.*
19. *Lala, R. M., For the Love of India: The Life and Times of Jamsetji Tata. New Delhi: Penguin, 2006.*
20. *Thapar, Romila. The Penguin History of Early India: From the Origins to AD 1300. New Delhi Penguin, 2002.*
21. *Majumdar, R. C., et. al. An Advanced History of India. Macmillan.*

15HUM234 HEALTH AND LIFE STYLE 1 0 2 2

Unit 1 Introduction to Health

Health is wealth; Role of lifestyle habits on health; Importance of adolescence; Stages, Characteristics and changes during adolescence; Nutritional needs during adolescence why healthy lifestyle is important for adolescence. Eating Habits - eating disorders, skipping breakfast, junk food consumption.

Practicals - Therapeutic Diets

Unit 2 Food and Nutritional Requirements during Adolescence

Fluid intake; nutrition related problems; lifestyle related problems, Role of physical activity; resting pattern and postures, Personal habits – alcoholism, and other tobacco products, electronic addiction etc

Practicals - Ethnic Foods

Unit 3 Need for a Positive Life Style Change

Peer pressure & procrastination, Stress, depression, suicidal tendency, Mini project review and viva, Whole portions revision.

Practical - Cooking without Fire or Wire-healthy Snacks

TEXTBOOKS:

B. Srilakshmi, "Dietetics", New age international (P) ltd, publishers, 2010.

Nutrient requirement and Recommended Dietary Allowances for Indians", published by Indian Council of Medical Research, ICMR, 2010.

REFERENCE BOOKS:

K Park "Textbook of preventive and social medicine", 2010.

WHO Report on Adolescent Health: 2010

15HUM235 INDIAN CLASSICS FOR THE TWENTY-FIRST CENTURY 2 0 0 2

Unit 1

Introductory study of the Bhagavad Gita and the Upanishads.

Unit 2

The relevance of these classics in a modern age.

Unit 3

Goals of human life - existential problems and their solutions in the light of these classics etc.

REFERENCE:

The Bhagavad Gita, Commentary by Swami Chinmayananda

15HUM236 INTRODUCTION TO INDIA STUDIES 2 0 0 2

PREAMBLE: This paper will introduce the students to the multiple dimensions of the contribution of India to the fields of philosophy, art, literature, physical and social sciences. The paper intends to give an insight to the students about the far-

reaching contributions of India to world culture and thought during the course of its long journey from the hoary antiquity to the present times. Every nation takes pride in its achievements and it is this sense of pride and reverence towards the achievements that lays the foundation for its all-round progress.

Unit 1

A brief outline of Indian history from prehistoric times to the present times.

Contributions of India to world culture and civilization: Indian Philosophy and Religion;Art and Literature; Physical and Social Sciences.

Unit 2

Modern India: Challenges and Possibilities.

Scientific and technological progress in post-independence era; Socio-cultural and political movements after independence; Challenges before the nation today - unemployment – corruption – degradation of cultural and moral values - creation of a new system of education; Creation of a modern and vibrant society rooted in traditional values.

Unit 3

Modern Indian Writing in English: Trends in Contemporary Indian Literature in English.

TEXTBOOK:

Material given by the Faculty

BACKGROUND LITERATURE:

1 *Selections from The Cultural Heritage of India, 6 volumes, Ramakrishna Mission Institute of Culture (Kolkata) publication.*
2 *Selections from the Complete Works of Swami Vivekananda, Advaita Ashrama publication.*
3 *Invitations to Indian Philosophy, T. M. P. Mahadevan, University of Madras, Chennai.*
4 *Outlines of Indian Philosophy, M. Hiriyanna, MLBD.*
5 *An Advanced History of India, R. C. Majumdar et al, Macmillan.*
6 *India Since 1526, V. D. Mahajan, S. Chand & Company*
7 *The Indian Renaissance, Sri Aurobindo.*
8 *India's Rebirth, Sri Aurobindo.*
9 *On Nationalism, Sri Aurobindo.*
10 *The Story of Civilization, Volume I: Our Oriental Heritage, Will Durant, Simonand Schuster, New York.*
11 *Eternal Values for a Changing Society, Swami Ranganathananda, Bharatiya Vidya Bhavan.*
12 *Universal Message of the Bhagavad Gita, Swami Ranganathananda, Advaita Ashrama.*
13 *Awaken Children: Conversations with Mata Amritanandamayi*
14 *Indian Aesthetics, V. S. Seturaman, Macmillan.*

15 *Indian Philosophy of Beauty, T. P. Ramachandran, University of Madras, Chennai.*
16 *Web of Indian Thought, Sister Nivedita*
17 *Essays on Indian Nationalism, Anand Kumaraswamy*
18 *Comparative Aesthetics, Volume 2, Kanti Chandra Pandey, Chowkhamba, Varanasi*
19 *The Invasion That Never Was, Michel Danino*
20 *Samskara, U. R. Ananthamurthy, OUP.*
21 *Hayavadana, Girish Karnard, OUP.*
22 *Naga-Mandala, Girish Karnard, OUP.*

15HUM237 INTRODUCTION TO SANSKRIT LANGUAGE AND LITERATURE 2 0 0 2

OBJECTIVES: *To familiarize students with Sanskrit language; to introduce students to various knowledge traditions in Sanskrit; to help students appreciate and imbibe India's ancient culture and values.*

Unit 1

Sanskrit Language – Vakya Vyavahara (प्रथमादीक्षा) - Introduction to Sanskrit language - Devanagari script and Sanskrit alphabet - Vowels and Consonants – Pronunciation - Classification of Consonants – Samyukthakshara Words – Nouns and Verbs - Cases – Introduction to Numbers and Time – Verbs: Singular, Dual and Plural – Sarva Namas: First Person, Second Person, Third Person – Tenses: Past, Present and Future -Words for Communication – Selected Slokas – Moral Stories – Subhashithas – Riddles.

Unit 2

Language Studies - Role of Sanskrit in Indian & World Languages.

Unit 3

Introduction to Sanskrit Classical Literature – KavyaTradition – Drama Tradition - Stotra Tradition – Panchatantra Stories.

Unit 4

Introduction to Sanskrit Technical Literature – Astronomy – Physics – Chemistry – Botany – Engineering – Aeronautics – Ayurveda – Mathematics – Medicine – Architecture - Tradition of Indian Art – Administration – Agriculture.

Unit 5

Indology Studies – Perspectives and Innovations.

TEXTBOOKS AND REFERENCE BOOKS:

1. *Vakya Vyavahara - Prof. Vempaty Kutumba Sastri, Rashtriya Sanskrit Sansthan, New Delhi*
2. *The Wonder that is Sanskrit - Dr. Sampadananda Mishra, New Delhi*
3. *Science in Sanskrit – Samskritha Bharathi, New Delhi*

15HUM238 NATIONAL SERVICE SCHEME 2 0 0 2

Unit 1

Introduction to Basic Concepts of NSS: History, philosophy, aims and objectives of NSS, Emblem, flag, motto, song, badge etc., Organisational structure, roles and responsibilities of various NSS functionaries.

NSS Programmes and Activities: Concept of regular activities, special campaigning, Day Camps, Basis of adoption of village / slums, methodology of conducting survey, financial pattern of the scheme, other youth programme/schemes of GOI, Coordination with different agencies, Maintenance of the Diary.

Unit 2

Volunteerism and Shramdan: Indian Tradition of volunteerism, Needs and importance of volunteerism, Motivation and Constraints of volunteerism, Shramdan as part of volunteerism, Amalabharatam Campaign, Swatch Bharath.

Unit 3

Understanding youth: Definition, profile and categories of youth, Issues, challenges and opportunities for youth, Youth as an agent of social change.

Youth and Yoga: History, philosophy and concept of Yoga, Myths and misconceptions about Yoga, Different Yoga traditions and their impacts, Yoga as a preventive and curative method, Yoga as a tool for healthy life style

Unit 4

Youth Development Programmes in India: National Youth Policy, Youth development programmes at the national level, state level and voluntary sector, youth-focused and youth-led organizations.

Youth and Crime: Sociological and psychological factors influencing youth crime, Peer mentoring in preventing crimes, Awareness about Anti-Ragging, Cyber Crime and its prevention, Juvenile Justice.

Unit 5

Environmental Issues: Environment conservation, enrichment and sustainability, climate change, waste management, rain water harvesting, energy conservation, waste land development.

Project Work / Practical

15HUM239 PSYCHOLOGY FOR EFFECTIVE LIVING 2 0 0 2

Unit 1 Self-Awareness & Self-Motivation

Self analysis through SWOT, Johari Window, Maslow's hierarchy of motivation, importance of self esteem and enhancement of self esteem.

Unit 2 The Nature and Coping of Stress

Conflict, Relationship issues, PTSD. Stress – stressors – eustress - distress, coping with stress, stress management techniques.

Unit 3 Application of Health Psychology

Health compromising behaviours, substance abuse and addiction.

TEXTBOOKS:

1. *V. D. Swaminathan & K. V. Kaliappan "Psychology for effective living-An introduction to Health*
2. *Psychology.2nd edition Robert J. Gatchel, Andrew Baum & David S. Krantz, McGraw Hill.*

REFERENCE BOOKS:

1. *S. Sunder, 'Textbook of Rehabilitation', 2nd edition, Jaypee Brothers, New Delhi.2002.*
2. *Weiben & Lloyd, 'Psychology applied to Modern Life', Thompson Learning, Asia Ltd.2004.*

15HUM240 PSYCHOLOGY FOR ENGINEERS 2 0 0 2

Unit 1

Psychology of Adolescents: Adolescence and its characteristics.

Unit 2

Learning, Memory & Study Skills: Definitions, types, principles of reinforcement, techniques for improving study skills, Mnemonics.

Unit 3

Attention & Perception: Definition, types of attention, perception.

TEXTBOOKS:

1. *S. K. Mangal, "General Psychology", Sterling Publishers Pvt.Ltd.2007*
2. *Baron A. Robert, "Psychology", Prentice Hall of India. New Delhi 2001*

REFERENCE BOOKS:

1. *Elizabeth B. Hurlock, Developmental Psychology - A life span approach, 6th edition.*
2. *Feldman, Understanding Psychology, McGraw Hill, 2000.*
3. *Clifford Morgan, Richard King, John Scholper, "Introduction to Psychology", Tata Mcgraw Hill, Pvt Ltd 2004.*

15HUM241 SCIENCE AND SOCIETY – AN INDIAN PERSPECTIVE 2 0 0 2

Unit 1

Introduction

Western and Indian views of science and technology

Introduction; Francis Bacon: the first philosopher of modern science; The Indian tradition in science and technology: an overview.

Unit 2

Indian sciences

Introduction; Ancient Indian medicine: towards an unbiased perspective; Indian approach to logic; The methodology of Indian mathematics; Revision of the traditional Indian planetary model by Nilakantha Somasutvan in circa 1500 AD

Science and technology under the British rule

Introduction; Indian agriculture before modernization; The story of modern forestry in India; The building of New Delhi

Unit 3

Science and technology in Independent India

Introduction; An assessment of traditional and modern energy resources; Green revolution: a historical perspective; Impact of modernisation on milk and oilseeds economy; Planning without the spirit and the determination.

Building upon the Indian tradition

Introduction; Regeneration of Indian national resources; Annamahatmyam and Annam Bahu Kurvita: recollecting the classical Indian discipline of growing and sharing food in plenty and regeneration of Indian agriculture to ensure food for all in plenty.

Conclusion

REFERENCES:

1. *Joseph, George Gheverghese. The Crest of the Peacock: Non-European Roots of Mathematics. London: Penguin (UK),2003.*
2. *Iyengar, C. N. Srinivasa. History of Hindu Mathematics. Lahore: 1935, 1938 (2 Parts).*
3. *Amma, T. A. Saraswati. Geometry in Ancient and Medieval India. Varanasi: Motilal Banarsidass, 1979.*
4. *Bag, A. K. Mathematics in Ancient and Medieval India. Varanasi: Motilal Banarsidass, 1979.*
5. *Sarma K. V. & B. V. Subbarayappa. Indian Astronomy: A Source-Book. Bombay: Nehru Centre, 1985.*
6. *Sriram, M. S. et. al. eds. 500 Years of Tantrasangraha: A Landmark in the History of Astronomy. Shimla: Indian Institute of Advanced Study, 2002.*
7. *Bajaj, Jitendra & M. D. Srinivas. Restoring the Abundance: Regeneration of Indian Agriculture to Ensure Food for All in Plenty. Shimla: Indian Institute of Advanced Study, 2001.*

8. *Bajaj, Jitendra ed. Report of the Seminar on Food for All: The Classical Indian Discipline of Growing and Sharing Food in Plenty. Chennai: Centre for Policy Studies, 2001.*
9. *Bajaj, Jitendra & M. D. Srinivas. Annam Bahu Kurvita: Recollecting the Indian Discipline of Growing and Sharing Food in Plenty. Madras: Centre for Policy Studies, 1996.*
10. *Parameswaran, S. The Golden Age of Indian Mathematics. Kochi: Swadeshi Science Movement.*
11. *Somayaji, D. A. A Critical Study of Ancient Hindu Astronomy. Dharwar: 1972.*
12. *Sen, S. N. & K. V. Sarma eds. A History of Indian Astronomy. New Delhi, 1985.*
13. *Rao, S. Balachandra. Indian Astronomy: An Introduction. Hyderabad: Universities Press, 2000.*
14. *Bose, D. M. et. al. A Concise History of Science in India. New Delhi: 1971.*
15. *Bajaj, Jitendra & M. D. Srinivas. Indian Economy and Polity. Chennai: Centre for Policy Studies.*
16. *Bajaj, Jitendra & M. D. Srinivas. Timeless India, Resurgent India. Chennai: Centre for Policy Studies.*
17. *Joshi, Murli Manohar. Science, Sustainability and Indian National Resurgence. Chennai: Centre for Policy Studies, 2008.*
18. *The Cultural Heritage of India. Kolkata: Ramakrishna Mission Institute of Culture.*

* The syllabus and the study material in use herein has been developed out of a ‘summer programme’ offered by the Centre for Policy Studies (CPS), Chennai at the Indian Institute of Advanced Study (IIAS), Rashtrapati Nivas, Shimla, sometime ago. The same has been very kindly made available to us by Professors Dr M.D. Srinivas (Chairman) and Dr J.K. Bajaj (Director) of the CPS.

15HUM242 THE MESSAGE OF BHAGWAD GITA 2 0 0 2

Unit 1

Introduction: Relevance of Bhagavad Gita today – Background of Mahabharatha.

ArjunaVishada Yoga: Arjuna’s Anguish and Confusion – Symbolism of Arjuna’s Chariot.

Sankhya Yoga: Importance of Self-knowledge – Deathlessness: Indestructibility of Consciousness – Being Established in Wisdom – Qualities of a Sthita-prajna.

Unit 2

Karma Yoga: Yoga of Action – Living in the Present – Dedicated Action without Anxiety over Results - Concept of Swadharma.

Dhyana Yoga: Tuning the Mind – Quantity, Quality and Direction of Thoughts – Reaching Inner Silence.

Unit 3

Bhakti Yoga: Yoga of Devotion – Form and Formless Aspects of the Divine – Inner Qualities of a True Devotee.

Gunatraya Vibhaga Yoga: Dynamics of the Three Gunas: Tamas, Rajas, Sattva – Going Beyond the Three Gunas – Description of a Gunatheetha.

TEXTBOOKS / REFERENCES:

1. *Swami Chinmayananda, "The Holy Geeta", Central Chinmaya Mission Trust, 2002.*
2. *Swami Chinmayananda, "A Manual of Self Unfoldment", Central Chinmaya Mission Trust, 2001.*

15HUM243 THE MESSAGE OF THE UPANISHADS 2 0 0 2

OBJECTIVES: *To give students an introduction to the basic ideas contained in the Upanishads; and explores how their message can be applied in daily life for achieving excellence.*

Unit 1

An Introduction to the Principal Upanishads and the Bhagavad Gita - Inquiry into the mystery of nature - Sruti versus Smrti - Sanatana Dharma: its uniqueness - The Upanishads and Indian Culture - Upanishads and Modern Science.

Unit 2

The challenge of human experience & problems discussed in the Upanishads – the True nature of Man – the Moving power of the Spirit – The Message of Fearlessness – Universal Man - The central problems of the Upanishads – Ultimate reality – the nature of Atman - the different manifestations of consciousness.

Unit 3

Upanishad Personalities - episodes from their lives and essential teachings: Yajnavalkya, Aruni, Uddalaka, Pippalada, Satyakama Jabala, Svetaketu, Nachiketas, Upakosala, Chakrayana Ushasti, Raikva, Kapila and Janaka. Important verses from Upanishads - Discussion of Sage Pippalada's answers to the six questions in Prasnopanishad.

REFERENCES:

1. *The Message of the Upanishads by Swami Ranganathananda, Bharatiya Vidya Bhavan*
2. *Eight Upanishads with the commentary of Sankaracharya, Advaita Ashrama*
3. *Indian Philosophy by Dr. S. Radhakrishnan, Oxford University Press*
4. *Essentials of Upanishads by R L Kashyap, SAKSI, Bangalore*
5. *Upanishads in Daily Life, Sri Ramakrishna Math, Mylapore.*
6. *Eternal stories of the Upanishads by Thomas Egenes and Kumuda Reddy*
7. *Upanishad Ganga series – Chinmaya Creations*

15HUM244 UNDERSTANDING SCIENCE OF FOOD AND NUTRITION 1 0 2 2

Unit 1 Food and Food Groups

Introduction to foods, food groups, locally available foods, Nutrients, Cooking methods, Synergy between foods, Science behind foods, Food allergies, food poisoning, food safety standards.

Cookery Practicals - Balanced Diet

Unit 2 Nutrients and Nutrition

Nutrition through life cycle, RDA, Nutrition in disease, Adulteration of foods & Food additives, Packaging and labeling of foods.

Practicals - Traditional Foods

Unit 3 Introduction to Food Biotechnology

Future foods - Organic foods and genetically modified foods, Fortification of foods value addition of foods, functional foods, Nutraceuticals, supplementary foods, Processing and preservation of foods, applications of food technology in daily life, and your prospects associated with food industry – Nanoparticles, biosensors, advanced research.

Practicals - Value added foods

TEXTBOOKS:

1. *N.Shakuntalamanay, M. Shadaksharaswamy, "Food Facts and principles", New age international (P) ltd, publishers, 2005.*
2. *B.Srilakshmi, "Dietetics", New age international (P) ltd, publishers, 2010.*

REFERENCE BOOKS:

1. *B. Srilakshmi, "Food Science", New age international (P) ltd, publishers, 2008.*
2. *"Nutrient requirement and Recommended Dietary Allowances for Indians", published by Indian Council of Medical Research, ICMR, 2010.*

15JAP230 PROFICIENCY IN JAPANESE LANGUAGE (LOWER) 1 0 2 2

This paper will introduce the basics of Japanese language. Students will be taught the language through various activities like writing, reading, singing songs, showing Japanese movies etc. Moreover this paper intends to give a thorough knowledge on Japanese scripts that is Hiragana and Katakana. Classes will be conducted throughout in Japanese class only. Students will be able to make conversations with each other in Japanese. Students can make self-introduction and will be able to write letters in Japanese. All the students will be given a text on Japanese verbs and tenses.

Students can know about the Japanese culture and the lifestyle. Calligraphy is also a part of this paper. Informal sessions will be conducted occasionally, in which students can sing Japanese songs, watch Japanese movies, do Origami – pattern making using paper.

15JAP231 PROFICIENCY IN JAPANESE LANGUAGE (HIGHER) 1 0 2 2

Students will be taught the third and the most commonly used Japanese script, Kanji. Students will be taught to write as well as speak.

Students will be given detailed lectures on Calligraphy.

This version of the course includes a new project where the students should make a short movie in Japanese language selecting their own topics.

By the end of the semester they the students will master the subject in all means. They will be able to speak Japanese as fluently as they speak English. Students will be encouraged to write stories and songs in Japanese language themselves.

15KAN101 KANNADA I 1 0 2 2

OBJECTIVES: *To enable the students to acquire basic skills in functional language; to develop independent reading skills and reading for appreciating literary works; to analyse language in context to gain an understanding of vocabulary, spelling, punctuation and speech.*

Unit 1
Adalitha Kannada: bhashe, swaroopa, belavanigeya kiru parichaya
Paaribhaashika padagalu
Vocabulary Building

Unit 2
Prabhandha – Vyaaghra Geethe - A.N.Murthy Rao
Prabhandha – Baredidi…baredidi, Baduku mugiyuvudilla allige…- Nemi Chandra
Paragraph writing – Development: comparison, definition, cause & effect
Essay – Descriptive & Narrative

Unit 3
Mochi – Bharateepriya
Mosarina Mangamma – Maasti Venkatesh Iyengar
Kamalaapurada Hotelnalli – Panje Mangesh Rao
Kaanike – B. M. Shree
Geleyanobbanige bareda Kaagada – Dr. G. S. Shivarudrappa
Moodala Mane – Da .Ra. Bendre
Swathantryada Hanate – K. S. Nissaar Ahmed

Unit 4
Letter Writing - Personal: Congratulation, thanks giving, invitation, condolence

Unit 5
Reading Comprehension; nudigattu, gaadegalu
Speaking Skills: Prepared speech, pick and speak

REFERENCES:

1. *H. S. Krishna Swami Iyangar – Adalitha Kannada – Chetana Publication, Mysuru*
2. *A. N. Murthy Rao – Aleyuva Mana – Kuvempu Kannada Adyayana Samste*
3. *Nemi Chandra – Badhuku Badalisabahudu – Navakarnataka Publication*
4. *Sanna Kathegalu - Prasaranga, Mysuru University , Mysuru*
5. *B. M. Shree – Kannadada Bavuta – Kannada Sahitya Parishattu*
6. *K. S. Nissar Ahmed – 75 Bhaavageetegalu – Sapna Book House (P) Ltd.*
7. *Dr. G. S. Shivarudrappa – Samagra Kavya – Kamadhenu Pustaka Bhavana*

15KAN111 KANNADA II 1 0 2 2

OBJECTIVES: *To enable the students to acquire basic skills in functional language; to develop independent reading skills and reading for appreciating literary works; to develop functional and creative skills in language; to enable the students to plan, draft, edit & present a piece of writing.*

Unit 1
Official Correspondence: Adhikrutha patra, prakatane, manavi patra, vanijya patra

Unit 2
Nanna Hanate - Dr. G. S. Shivarudrappa
Mankuthimmana Kaggada Ayda bhagagalu – D. V. Gundappa (Padya Sankhye 5, 20, 22, 23, 25, 44, 344, 345, 346, 601)
Ella Marethiruvaga - K. S. Nissaar Ahmed
Saviraru Nadigalu – S Siddalingayya

Unit 3
Sayo Aata – Da. Ra. Bendre

Unit 4
Sarva Sollegala turtu Maha Samelana - Beechi
Swarthakkaagi Tyaga - Beechi

Unit 5
Essay writing: Argumentative & Analytical
Précis writing

REFERENCES:

1. *H. S. Krishnaswami Iyangar – Adalitha Kannada – Chetan Publication, Mysuru*

2. Dr. G. S. Shivarudrappa – Samagra Kavya. - Kamadhenu Pustaka Bhavana
3. Shrikanth - Mankuthimmana Kagga – Taatparya – Sri Ranga Printers & Binders
4. K. S. Nissar Ahmed – 75 Bhaavageetegalu – Sapna book house
5. Dr. Da. Ra. Bendre – Saayo Aata – Shri Maata Publication
6. Beechi – Sahukara Subbamma – Sahitya Prakashana

15MAL101 MALAYALAM I 1 0 2 2

OBJECTIVES: *To appreciate the aesthetics & cultural implications; to enhance creative thinking in mother-tongue; to learn our culture & values; to equip students read & write correct Malayalam; to correct the mistakes in pronunciation; to create awareness that good language is the sign of complete personality.*

Unit 1

Ancient poet trio: Adhyatmaramayanam ,
Lakshmana Swanthanam (valsa soumitre... mungikidakayal), Ezhuthachan - Medieval period classics – Jnanappana (kalaminnu... vilasangalingane), Poonthanam.

Unit 2

Modern Poet trio: Ente Gurunathan, Vallathol Narayana Menon - Critical analysis of the poem.

Unit 3

Short stories from period 1/2/3, Poovanpazham - Vaikaom Muhammed Basheer - Literary & Cultural figures of Kerala and about their literary contributions.

Unit 4

Literary Criticism: Ithihasa studies - Bharatha Paryadanam - Vyasante Chiri - Kuttikrishna Mararu - Outline of literary Criticism in Malayalam Literature - Introduction to Kutti Krishna Mararu & his outlook towards literature & life.

Unit 5

Error-free Malayalam: 1. Language; 2. Clarity of expression; 3. Punctuation – Thettillatha Malayalam

Writing - a. Expansion of ideas; b. Precis Writing; c. Essay Writing; d. Letter writing; e. Radio Speech; f. Script / Feature / Script Writing; g. News Editing; h. Advertising; i. Editing; j. Editorial Writing; k. Critical appreciation of literary works (Any one or two as an assignment).

REFERENCES:

1. P. K. Balakrishnanan, Thunjan padhanangal, D. C. Books, 2007.
2. G. Balakrishnan Nair, Jnanappanayum Harinama Keerthanavum, N. B. S, 2005.

3. M. N. Karasseri, Basheerinte Poonkavanam, D. C. Books, 2008.
4 M. N. Vijayan, Marubhoomikal Pookkumbol, D. C. Books, 2010.
5. M. Thomas Mathew, LavanyanubhavathinteYukthisasthram, National Book Stall, 2009.
6. M. Leelavathy, Kavitha Sahityacharitram, National Book Stall, 1998.
7. Thayattu Sankaran, Vallathol Kavithapadhanam, D. C. Books, 2004.

15MAL111 MALAYALAM II 1 0 2 2

OBJECTIVES: *To appreciate the aesthetics & cultural implications; to enhance creative thinking in mother-tongue; to learn our culture & values; to equip students read & write correct Malayalam; to correct the mistakes in pronunciation; to create awareness that good language is the sign of complete personality.*

Unit 1

Ancient poet trio: Kalayana sougandhikam, (kallum marangalun... namukkennarika vrikodara) Kunjan Nambiar - Critical analysis of his poetry - Ancient Drama: Kerala Sakunthalam (Act 1), Kalidasan (Transilated by Attor Krishna Pisharody).

Unit 2

Modern / romantic / contemporary poetry: Manaswini, Changampuzha Krishna Pillai – Romanticism – modernism.

Unit 3

Anthology of short stories from period 3/4/5: Ninte Ormmayku, M. T. Vasudevan Nair - literary contributions of his time

Unit 4

Part of an autobiography / travelogue: Kannerum Kinavum, V. T. Bhattathirippadu - Socio-cultural literature - historical importance.

Unit 5

Error-free Malayalam - 1. Language; 2. Clarity of expression; 3. Punctuation - Thettillatha Malayalam

Writing - a. Expansion of ideas; b. Précis Writing ; c. Essay Writing; d. Letter writing; e. Radio Speech; f. Script / Feature / Script Writing; g. News Editing; h. Advertising; i. Editing; j. Editorial Writing; k. Critical appreciation of literary works (Any one or two as an assignment).

REFERENCES:

1. Narayana Pillai. P. K, Sahitya Panchanan. Vimarsanathrayam, Kerala Sahitya Academy, 2000
2. Sankunni Nair. M. P, Chathravum Chamaravum, D. C. Books, 2010.
3. Gupthan Nair. S, Asthiyude Pookkal, D. C Books.2005

4. *Panmana Ramachandran Nair, Thettillatha Malayalam, Sariyum thettum etc., D. C. Book, 2006.*
5. *M. Achuthan, Cherukatha-Innale, innu, National Book Stall, 1998.*
6. *N. Krishna Pillai, Kairaliyude Katha, National Book Stall, 2001.*

15MAT111 CALCULUS AND MATRIX ALGEBRA 2 1 0 3

Unit 1 Calculus
Graphs: Functions and their Graphs. Shifting and Scaling of Graphs.

Limit and Continuity: Limit (One-Sided and Two-Sided) of Functions. Continuous Functions, Discontinuities, Monotonic Functions, Infinite Limits and Limit at Infinity.

Unit 2 Differentiation and its Applications: Derivative of a function, non differentiability, Intermediate Value Property, Mean Value Theorem, Extreme Values of Functions, Monotonic Functions, Concavity and Curve Sketching, Integration: Definite Integrals, The Mean Value Theorem for definite integrals, Fundamental Theorem of Calculus, Integration Techniques.

Unit 3 Matrix Algebra
Review: System of linear Equations, linear independence

Eigen values and Eigen vectors: Definitions and Properties, Positive definite, Negative Definite and Indefinite Matrices, Diagonalization and Orthogonal Diagonalization, Quadratic form, Transformation of Quadratic Form to Principal axes, Symmetric and Skew Symmetric Matrices, Hermitian and Skew Hermitian Matrices and Orthogonal Matrices Iterative Methods for the Solution of Linear Systems, Power Method for Eigen Values and Eigen Vectors.

TEXTBOOKS:

1. *'Calculus', G. B. Thomas Pearson Education, 2009, Eleventh Edition.*
2. *'Advanced Engineering Mathematics', Erwin Kreyszig, John Wiley and Sons, 2015, Tenth Edition.*

REFERENCE BOOKS:

1. *'Calculus', Monty J. Strauss, Gerald J. Bradley and Karl J. Smith, 3rd Edition, 2002.*
2. *'Advanced Engineering Mathematics', by Dennis G. Zill and Michael R. Cullen, second edition, CBS Publishers, 2012.*

15MAT121 VECTOR CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS 3 1 0 4

Unit 1
Vector Differentiation: Vector and Scalar Functions, Derivatives, Curves, Tangents, Arc Length, Curves in Mechanics, Velocity and Acceleration, Gradient of a Scalar

Field, Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field. (Sections: 9.4, 9.5, 9.6, 9.9, 9.10, 9.11)

Vector Integration: Line Integral, Line Integrals Independent of Path. Green's Theorem in the Plane (Sections: 10.1, 10.2, 10.3, 10.4).

Unit 2
Surface Integral: Surfaces for Surface Integrals, Surface Integrals, Triple Integrals – Gauss Divergence Theorem, Stoke's Theorem. (Sections: 10.5, 10.6, 10.7, 10.9)

First Order Differential Equations: First Order ODE, Exact Differential Equations and Integrating Factors (Sections 1.1and 1.4).

Unit 3
Second Order Differential Equations: Homogeneous and non-homogeneous linear differential equations of second order (Review), Modelling: Free Oscillations,

Euler-Cauchy Equations, Solution by Undetermined Coefficients, Solution by the Method of Variation of Parameters (Sections 2.1, 2.2, 2.4, 2.5, 2.6, 2.7, 2.10).

System of Order Differential Equations: Basic Concepts and Theory, Constant Coefficient systems – Phase Plane method, Criteria for Critical Points, Stability. (Sections 4.1 – 4.4).

TEXTBOOK:

'Advanced Engineering Mathematics', Erwin Kreyszig, John Wiley and Sons, Tenth Edition, 2015.

REFERENCE BOOKS:

1. *'Advanced Engineering Mathematics', Dennis G. Zill and Michael R. Cullen, second edition, CBS Publishers, 2012.*
2. *'Calculus', G. B. Thomas Pearson Education, 2009, Eleventh Edition.*
3. *'Calculus', Monty J. Strauss, Gerald J. Bradley and Karl J. Smith, 3rd Edition, 2002.*

15MAT201 DISCRETE MATHEMATICS 3 1 0 4

Unit 1
Logic, Mathematical Reasoning and Counting: Logic, Prepositional Equivalence, Predicate and Quantifiers, Theorem Proving, Functions, Mathematical Induction. Recursive Definitions, Recursive Algorithms, Basics of Counting, Pigeonhole Principle, Permutation and Combinations. (Sections: 1.1 -1.3, 1.5 -1.7, 2.3, 4.1 - 4.4, 5.1 - 5.3 and 5.5)

Unit 2
Relations and Their Properties: Representing Relations, Closure of Relations, Partial Ordering, Equivalence Relations and partitions. (Sections: 7.1, 7.3 - 7.6)

Advanced Counting Techniques and Relations: Recurrence Relations, Solving Recurrence Relations, Generating Functions, Solutions of Homogeneous Recurrence Relations, Divide and Conquer Relations, Inclusion-Exclusion. (Sections: 6.1 - 6.6)

Unit 3

Graph Theory: Introduction to Graphs, Graph Operations, Graph and Matrices, Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest Path Problem, Planar Graph, Graph Colorings and Chromatic Polynomials. (Sections: 8.1 - 8.8)

TEXTBOOK:

Kenneth H. Rosen, "Discrete Mathematics and its Applications", Tata McGraw- Hill Publishing Company Limited, New Delhi, Sixth Edition, 2007.

REFERENCES:

1. *R.P. Grimaldi, "Discrete and Combinatorial Mathematics", Pearson Education, Fifth Edition, 2007.*
2. *Thomas Koshy, "Discrete Mathematics with Applications", Academic Press, 2005.*
3. *Liu, "Elements of Discrete Mathematics", Tata McGraw Hill Publishing Company Limited, 2004.*

15MAT202 LINEAR ALGEBRA 2 1 0 3

Unit 1

Vector Spaces: Vector spaces - Sub spaces - Linear independence - Basis - Dimension - Inner products - Orthogonality - Orthogonal basis - Gram Schmidt Process.

Unit 2

Change of basis - Orthogonal complements - Projection on subspace - Least Square Principle. Linear Transformations: Positive definite matrices - Matrix norm and condition number – QR - Decomposition

Unit 3

Linear transformation - Relation between matrices and linear transformations - Kernel and range of a linear transformation - Change of basis - Nilpotent transformations - Similarity of linear transformations - Diagonalisation and its applications - Jordan form and rational canonical form.

TEXTBOOK:

Howard Anton and Chris Rorres, "Elementary Linear Algebra", Tenth Edition, John Wiley & Sons, 2010.

REFERENCES:

1. *Gilbert Strang, "Linear Algebra and Its Applications", Fourth Edition, Cengage, 2006.*
2. *Kenneth Hoffmann and Ray Kunze, Linear Algebra, Second Edition, Prentice Hall, 1971.*

15MAT203 TRANSFORMS AND COMPLEX ANALYSIS 3 1 0 4

Unit 1

Laplace Transform: Laplace Transforms, Inverse Transforms, Linearity, Shifting, Transforms of Derivatives and Integrals, Differential Equations, Unit Step Function, Second Shifting Theorem, Dirac's Delta Function. Differentiation and Integration of Transforms. Convolution, Integral Equations, Partial Fractions, Differential Equations, Systems of Differential Equations.

Unit 2

Fourier Series: Fourier series, Half range Expansions, Parseval's Identity, Fourier Integrals, Fourier integral theorem. Sine and Cosine Integrals.

Fourier Transforms: Sine and Cosine Transforms, Properties, Convolution theorem.

Unit 3

Complex Analysis: Complex Numbers, Complex Plane, Polar Form of Complex Numbers. Powers and Roots, Derivative. Analytic Functions, Cauchy - Riemann Equations, Laplace Equation, Conformal mapping, Exponential Function, Trigonometric Functions, Hyperbolic Functions, Logarthims, General Power, Linear Fractional Transformation. Complex Line Integral, Cauchy Integral Theorem, Cauchy Integral Formula, Derivatives of Analytic Functions.

Power Series, Taylor Series and Maclaurin Series. Laurent Series, Zeros and Singularities, Residues, Cauchy Residue Theorem, Evaluation of Real Integrals using Residue Theorem.

TEXTBOOK:

Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Ninth Edition, 2012.

REFERENCE BOOKS:

1. *Advanced Engineering Mathematics by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.*
2. *Larry C. Andrews and Bhimson. K. Shivamoggi, The Integral Transforms for Engineers, Spie Press, Washington, 1999.*
3. *J. L. Schiff, The Laplace Transform, Springer, 1999*

15MAT204 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS 2 1 0 3

Unit 1

Laplace Transform: Laplace Transforms, Inverse Transforms, Linearity, Shifting, Transforms of Derivatives and Integrals, Differential Equations, Unit Step Function,

Second Shifting Theorem, Dirac's Delta Function. Differentiation and Integration of Transforms.

Unit 2

Convolution, Integral Equations, Partial Fractions, Differential Equations, Systems of Differential Equations. (Sections: 6.1 to 6.7)

Fourier Series: Fourier series, Half range Expansions, Parseval's Identity, Fourier Integrals, Fourier integral theorem. Sine and Cosine Integrals. (Sections: 11.1 - 11.3)

Unit 3

Fourier Transforms: Sine and Cosine Transforms, Properties, Convolution theorem. (Sections: 11.1 -11.3, 11.7-11.9)

Partial Differential Equations: Basic Concepts, Modeling; Vibrating String, Wave Equation, Separation of Variables, Use of Fourier Series, Heat Equation; Solution by Fourier Series. (Sections: 12.1-12.5)

TEXTBOOK:

Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Ninth Edition, 2012.

REFERENCE BOOKS:

1. *Advanced Engineering Mathematics by Dennis G. Zill and Michael R. Cullen, second edition, CBS Publishers, 2012.*
2. *Larry C. Andrews and Bhimson. K. Shivamoggi, The Integral Transforms for Engineers, Spie Press, Washington, 1999.*
3. *J. L. Schiff, The Laplace Transform, Springer, 1999.*

15MAT211 CALCULUS OF VARIATIONS AND NUMERICAL METHODS 2 1 0 3

Unit 1

Calculus of Variations: Maxima and minima - The simplest case - Illustrative examples - Natural boundary conditions and transition conditions – Concept of functional with simple example – Variation of a functional (only necessary conditions) - Simple variational problem - Euler equation - The more general case of variational problems - Constraints and Lagrange multipliers - Variable end points.

Unit 2

Sturm-Liouville problems - Hamilton's principle - Lagrange's equations - Generalized dynamical entities - Constraints in dynamical systems - Applications in dynamics of particles, vibrating string, vibrating membranes, theory of elasticity - The variational problem of a vibrating elastic plate – Direct methods in calculus of variations - The Rayleigh-Ritz and finite difference methods. (Book-1)

Unit 3

Numerical Methods: Solution of Equations by iteration methods. Interpolations. Numerical Integration and Differentiation. (Book-2: Sections: 19.1-19.5)

TEXTBOOK:

1. *M. Gelfand and S. V. Fomin, Calculus of Variations, Dover Publications, 2000*
2. *Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Ninth Edition, 2012.*

REFERENCE BOOK:

1. *A. S. Gupta, calculus of Variations with Applications, Prentice Hall of India, 1997*
2. *M. K. Venkatraman, Advanced Engineering Mathematics, 2010.*
3. *M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical methods for Scientific and Engineering Computation, New Age International Publishers, Fifth ed., 2007.*
4. *Steven Chapra and Raymond Canale, Numerical Methods for Engineers, McGraw Hill, 2007.*

15MAT212 COMPLEX ANALYSIS AND NUMERICAL METHODS 2 1 0 3

Unit 1

Complex Numbers, Complex Plane, Polar Form of Complex Numbers. Powers and Roots, Derivative. Analytic Functions, Cauchy - Riemann Equations, Laplace Equation, Conformal mapping, Exponential Function, Trigonometric Functions, Hyperbolic Functions, Logarthims, General Power, Linear Fractional Transformation.

Unit 2

Complex Line Integral, Cauchy Integral Theorem, Cauchy Integral Formula, Derivatives of Analytic Functions. Power Series, Taylor Series and Maclaurin Series. Laurent Series, Zeros and Singularities, Residues, Cauchy Residue Theorem, Evaluation of Real Integrals using Residue Theorem.

Unit 3

Numerical Methods: Solution of Equations by iteration methods. Interpolations.

Numerical Integration and Differentiation. (Sections: 19.1-19.5)

TEXTBOOK:

Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Ninth Edition, 2012.

REFERENCE BOOK:

1. *S. Ponnusamy, Foundations of Complex Analysis, 2nd Edition, Narosa Publishing House, 2005.*
2. *R. Roopkumar, Complex Analysis, Pearson Education, 2014, Chennai.*

15MAT213 PROBABILITY AND RANDOM PROCESSES 3 1 0 4

Unit 1

Review of probability concepts - conditional probability - Bayes theorem.

Random Variable and Distributions: Introduction to random variable – discrete and continuous random variables and its distribution functions - mathematical expectations – moment generating function and characteristic function - Binomial, Poisson, Geometric, Uniform, Exponential, Normal distribution functions (moment generating function, mean, variance and simple problems) – Chebyshev's theorem.

Unit 2

Random processes: General concepts and definitions - stationarity in random processes - strict sense and wide sense stationary processes - autocorrelation and properties - special processes – Poisson points, Poisson and Gaussian processes and properties.

Unit 3

Systems with stochastic inputs - power spectrum- spectrum estimation, ergodicity –Markov process and Markov chain, transition probabilities, Chapman Kolmogrov theorem, limiting distributions classification of states.

TEXTBOOKS:

1. *Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, (2005) John Wiley and Sons Inc.*
2. *A. Papoulis, and Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", Fourth Edition, McGraw Hill, 2002.*

REFERENCE BOOKS:

1. *J. Ravichandran, "Probability and Random Processes for Engineers", First Edition, IK International, 2015.*
2. *Scott L. Miller, Donald G. Childers, "Probability and Random Processes", Academic press, 2012.*

15MAT214 PROBABILITY AND STATISTICS 2 1 0 3

Unit 1

Probability Concepts: Review of probability concepts - Bayes' Theorem.

Random Variable and Distributions: Introduction to random variable – discrete and continuous distribution functions - mathematical expectations – moment generating functions and characteristic functions. Binomial, Poisson, Geometric, Uniform, Exponential, Normal distribution functions (MGF, mean, variance and simple problems) – Chebyshev's theorem

Unit 2

Sampling Distributions: Distributions of Sampling Statistics, Chi-square, t and F distributions (only definitions and use). Central Limit Theorem.

Theory of estimation: Point Estimation, Unbiased estimator - Maximum Likelihood Estimator - Interval Estimation.

Unit 3

Testing of Hypothesis: Large and small sample tests for mean and variance – Tests based on Chi-square distribution.

TEXTBOOK:

Douglas C. Montgomery and George C.Runger, Applied Statistics and Probability for Engineers, (2005) John Wiley and Sons Inc.

REFERENCE BOOKS:

1. *J. Ravichandran, "Probability and Random Processes for Engineers", First Edition, IK International, 2015.*
2. *Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Probability and Statistics for Engineers and Scientists, 8th Edition (2007), Pearson Education Asia.*
3. *Sheldon M Ross, Introduction to Probability and Statistical Inference, 6th Edition, Pearson.*
4. *A. Papoulis, and Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", Fourth Edition, McGraw Hill, 2002.*

15MAT301 LINEAR ALGEBRA, QUEUING THEORY AND OPTIMIZATION 3 1 0 4

Unit 1

Introduction to Linear Algebra: Review of matrices and linear systems of equations.

Vector spaces and subspaces, linear independence, basis and dimensions, linear transformations, orthogonality, Orthogonal basis, Gram Schmidt Process, least-square applications.

Unit 2

Queueing Theory: Introduction to Queuing Models, Characteristics of Queuing Models, Single Channel Queuing Theory, Solution to Single Channel Queuing Models, Application of Queuing Theory.

Unit 3

Single Variable Optimization Techniques: Single variable optimization: Optimality criteria – bracketing methods – region elimination methods – point estimation method – gradient based methods.

TEXTBOOKS:

1. *Howard Anton and Chris Rorrs, "Elementary Linear Algebra", Ninth Edition, John Wiley & Sons, 2000.*

2. Kalyanmoy Deb, "Optimization for Engineering Design: Algorithms and Examples, Prentice Hall, 2002.
3. Operations Research - An Introduction, A H, Taha Macmillan Publishing Co.

15MAT302 NUMERICAL METHODS 2 0 2 3

Unit 1

Review of Errors: Accuracy and Precision, round-off error and truncation error. (Sec. 2.2-2.4)

Roots of Transcendental and Polynomial Equations: Bisection method, Iteration methods based on first degree equation, Rate of convergence, System of nonlinear equations. (Sec. 4.2, 4.3, 5.1-5.3, 5.5)

Review of Matrix Algebra: Systems of Equations, Eigenvalues and Eigen vectors.

Solution of System of Linear Algebraic Equations: Gauss Elimination and Gauss Jordan Methods. Iteration Methods. Eigenvalues and Eigenvectors: Jacobi Method for symmetric matrices and Power Method for arbitrary matrices. (Sec. 8.2, 8.7, 10.2, 22.2)

Unit 2

Interpolation and Approximation: Lagrange and Newton interpolation for unequal intervals, Finite difference operators, Interpolating polynomials using finite differences. (Sec. 13.1 – 13.4, 13.6)

Unit 3

Review of Ordinary Differential Equations:

Solutions of Ordinary Differential Equations: Initial value problems - Single step methods - Taylor Series Method, Second , Third and Fourth order Runge Kutta Methods. (Sec.20.1 – 20.3, 21.2)

Lab-Implementation of these methods: MATLAB or EXCEL or Free and Open Source Software (FOSS) tools like R-programming and Scilab.

TEXTBOOK:

Steven Chapra and Raymond Canale, Numerical Methods for Engineers, McGraw Hill, 2007.

REFERENCE BOOKS:

1. *M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical methods for Scientific and Engineering Computation, New Age International Publishers, Fifth edition, 2007.*
2. *C. F Gerald and P. O Wheatley, Applied Numerical Analysis, 7th edition, Addison Wesley, 2009.*
3. *Rizwan Butt, Introduction to Numerical Analysis Using MATLAB, Jones and Bartlett Publisher, 2010.*

4. Abdelwahab Kharab, Ronald B, An Introduction to Numerical Methods: A MATLAB Approach, Third Edition, CRC Press, 2012.

15MAT303 OPTIMIZATION TECHNIQUES 2 1 0 3

Unit 1

Introduction

Optimization - optimal problem formulation, engineering optimization problems, optimization algorithms, numerical search for optimal solution.

Unit 2

Single Variable optimization

Optimality criteria, bracketing methods - exhaustive search method, bounding phase method - region elimination methods - interval halving, Fibonacci search, golden section search, point estimation method - successive quadratic search, gradient based methods.

Unit 3

Multivariable Optimization

Optimality criteria, unconstrained optimization - solution by direct substitution, unidirectional search – direct search methods evolutionary search method, simplex search method, Hook-Jeeves pattern search method, gradient based methods – steepest descent, Cauchy's steepest descent method, Newton's method, conjugate gradient method - constrained optimization. Kuhn-Tucker conditions.

TEXTBOOK:

S. S. Rao, "Optimization Theory and Applications", Second Edition, New Age International (P) Limited Publishers, 1995.

REFERENCES:

1. *Kalyanmoy Deb, "Optimization for Engineering Design Algorithms and Examples", Prentice Hall of India, New Delhi, 2004.*
2. *Edwin K. P. Chong and Stanislaw H. Zak, "An Introduction to Optimization", Second Edition, Wiley-Interscience Series in Discrete Mathematics and Optimization, 2004.*
3. *M. Asghar Bhatti, "Practical Optimization Methods: with Mathematics Applications", Springer Verlag Publishers, 2000.*

15MEC100 ENGINEERING DRAWING - CAD 2 0 2 3

Introduction, Drawing Instruments and their uses, Layout of the Software, standard tool bar/menus, navigational tools. Co-ordinate system and reference planes. Creation of 2 dimensional environment. Selection of drawing size and scale. Commands and Dimensioning.

Orthographic Projections: Introduction, Planes of projection, reference line. Projection of points in all the four quadrants. Projection of straight lines, Projection of Plane Surfaces, and Projection of Solids in first angle projection system.

TEXTBOOK:

Bhat N. D. and Panchal V. M, "Engineering Drawing Plane and Solid Geometry" , 42e, Charoatar Publishing House, 2010

REFERENCES:

1. *James D. Bethune, "Engineering Graphics with AutoCAD", Pearson Education, 2014*
2. *K. R. Gopalakrishna, "Engineering Drawing", 2014, Subhas Publications*
3. *Narayan K. L. and Kannaiah P, Engineering Drawing, SciTech Publications, 2003*

15MEC101 ENGINEERING DRAWING - CAD II 2 0 2 3

Sections of Solids: Introduction, Section planes, Sectional views, apparent shapes and true shapes of sections of right regular prisms, cylinders, pyramids and cones.

Development of lateral surfaces: Introduction, Development of lateral surfaces of prisms, cylinders, pyramids and cones and their frustums & truncations.

Isometric Projection: Introduction, Isometric scale, Isometric projection of simple plane figures, Isometric projection of prisms, pyramids, cylinders, cones and simple Machine parts.

Orthographic Views of 3 dimensional solids.

TEXTBOOK:

Bhat N.D. and Panchal V.M., "Engineering Drawing Plane and Solid Geometry", 42e, Charoatar Publishing House, 2010

REFERENCES:

1. *James D. Bethune, "Engineering Graphics with AutoCAD", Pearson Education, 2014*
2. *K. R. Gopalakrishna, "Engineering Drawing", 2014, Subhas Publications*
3. *Narayan K. L. and Kannaiah P, Engineering Drawing, SciTech Publications, 2003*

15MEC102 ENGINEERING MECHANICS 3 0 0 3

Unit 1

Principles of Statics: Introduction to vector approach - free body diagrams - forces in plane - forces in space - concurrent forces - resolution of forces - equilibrium of particle.

Statics of rigid bodies in two dimension: Moment of a force about a point - moment of a couple - equivalent force - couple system. Rigid body equilibrium: Beams - support reactions.

Unit 2

Friction - block friction, ladder friction. Analysis of trusses - Method of joints, method of sections.

Centroid of lines, areas - composite areas. Second Moment of area - polar moment of inertia - mass moment of inertia - radius of gyration.

Unit 3

Dynamics of particles: Kinematics of particles - rectilinear motion - relative motion - position, velocity and acceleration calculations in cylindrical coordinates.
Dynamics of rigid bodies: General plane motion - translation and rotation of rigid bodies - Chasle's theorem.

TEXTBOOKS:

1. *Hibbeler, R.C., "Engineering Mechanics - Statics", 12/e, Pearson Education Pvt. Ltd., 2007.*
2. *Beer, F. P. & Johnston, E. R., "Vector Mechanics for Engineers - Statics and Dynamics", 8/e, McGraw Hill International Book Co., 2008.*

REFERENCES:

1. *Meriam, J. L., "Dynamics",5/e, John Wiley & sons,2003*
2. *Shames, I. H, "Engineering Mechanics - Statics and Dynamics", 4/e., Prentice-Hall of India Pvt. Ltd., 2003.*
3. *Dubey, N. H. "Engineering Mechanics" McGraw Hill*

15MEC111 FUNDAMENTALS OF MECHANICAL ENGINEERING 3 0 0 3

Unit 1

Principles of Statics – Introduction to Mechanics, Basic Concepts, Fundamentals and Principles. Statics of Particles in two dimension-Resolution of forces, Resultant force, equilibrium of particle, Freebody diagram, Lami's theorem. Statics of Rigid Bodies in two dimensions-Moment of a force about a point, Varignon's theorem, moment of a couple, resolution of a force system into a force couple system, reduction to a single force system. Equilibrium of rigid bodies-Analysis of beams, supports and reactions.

Unit 2

Thermodynamics – Introduction, Concepts of thermodynamic system, properties – specific volume, pressure, temperature – Zeroth law of thermodynamics, energy forms – work and heat.

First Law of Thermodynamics – for a closed system undergoing a cycle, for a process, energy as a property, specific heats, first law of TD applied to steady flow devices.

Second Law of Thermodynamics – concept of heat engines and refrigerators, Kelvin plank and Clausius statements, irreversibility, Carnot cycle, Clausius inequality, thermodynamic temperature scale, concept of entropy, principle of increase of entropy.

Unit 3

Engineering Materials – Types and applications of Ferrous & Non-ferrous metals and alloys, Composites: Introduction, Definition, Classification and applications Soldering, Brazing and Welding - Definitions, classification and method of soldering, brazing and welding. Differences between soldering, brazing and Welding. Description of Electric Arc Welding and Oxy-Acetylene Welding.

TEXTBOOKS:

1. *R. C. Hibbeler. "Engineering Mechanics - Statics", Pearson Education Asia, 2012*
2. *Y. A. Cengel and Michael A. Boles, " Thermodynamics – An Engineering Approach", Tata McGrawHill, 2013*
3. *V. K. Manglik. "Elements of Mechanical Engineering", PHI Learning Pvt. Ltd. 2013*

REFERENCES:

1. *J L Meriam & L. G Kraige. "Engineering Mechanics - Statics", 7th edition, Wiley India Pvt. Ltd, 2013*
2. *Beer and Johnston, "Vector Mechanics for Engineers", Tata McGraw Hill Publishing Company Ltd 2012*
3. *N. H Dubey. "Engineering Mechanics Statics and Dynamics", McGraw Hill, 2012*
4. *R. E. Sonntag, C. Borgnakka and G. J. Van Wylen, " Fundamentals of Thermodynamics", John Wiley & Sons, 2002*
5. *Hajra Choudhury, "Elements of Workshop Technology", Volume I, 15e*

15MEC180 WORKSHOP A 0 0 2 1

1. Product Detailing Workshop

Disassemble the product of sub assembly - Measure various dimensions using measuring instruments - Free hand rough sketch of the assembly and components - Name of the components and indicate the various materials used - Study the functioning of the assembly and parts - Study the assembly and components design for compactness, processing, ease of assembly and disassembly - Assemble the product or subassembly.

2. Pneumatics and PLC Workshop

Study of pneumatic elements - Design and assembly of simple circuits using basic pneumatic elements - Design and Assembly of simple circuits using Electro-pneumatics.

Study of PLC and its applications - Simple programming using ladder diagrams.

3. Sheet Metal Workshop

Study of tools and equipments - Draw development drawing of simple objects on sheet metal (cone, cylinder, pyramid, prism, tray etc.) Fabrication of components using small shearing and bending machines - Riveting and painting practice.

4. (a) Welding Workshop

Study of tools and equipments - Study of various welding methods - Arc welding practice and demonstration of gas welding and cutting.

(b) Demo and practice Workshop

Fitting: Study of tools, practice in chipping, filing and making joints.

Carpentry: Study of tools, planning practice and making joints

REFERENCE:

Concerned Workshop Manual

15MEC201 ENGINEERING THERMODYNAMICS 3 0 0 3

Unit 1

Introduction and importance of thermodynamics, different approaches in the study of thermodynamics, SI units, basic concepts and definitions – system, surroundings, types of systems, properties. Pressure measurement, thermodynamic equilibrium, quasi static process, cyclic process, and thermodynamic energy interactions - evaluation of work type interaction, heat interaction, energy and forms of energy, history of laws of thermodynamics.

First law for closed system, analysis of closed systems. Concept of Zeroth Law, thermometry, temperature scales.

Open systems - Conservation of Mass applied to control volume, application of steady state flow process for typical Work and Heat transfer devices. Throttling process, application of throttling process.

Unit 2

Second Law of Thermodynamics – statement of Kelvin-Planck and Clausius, Heat Engines, Heat Pump, Refrigerators – Reversible and Irreversible processes, the Carnot Cycle, Carnot engine and Carnot theorems.

The inequality of Clausius and thermodynamic Temperature scale, concept of entropy, Entropy change in different processes, principle of increase in entropy for closed systems.

Unit 3

Thermodynamic properties of fluids, Pure Substance, phase-change process of pure substance, P-V-T surface, T-v, p-v and other diagrams, specific internal energy and enthalpy and other properties and steam tables.

Perfect gas, equation of state, specific heats, characterization of thermodynamic processes. Real gas models - Van der waals equation, compressibility chart.

Thermodynamic property relations: Introduction, important mathematical relations, cyclic rule, Maxwell relations, enthalpy, entropy, internal energy and specific heat relations; Clausius-Clapeyron equation, Joule Thomson coefficient and inversion line.

TEXTBOOK:

Cengel Y. A. and Boles M. A. 'Thermodynamics - an Engineering Approach' - Tata McGraw hill - 2014 - 8th Edition

REFERENCES:

1. *Sonntag R. E., Borgnakke C. and Van Wylen, G. - "Fundamentals of Thermodynamics" - John Wiley and Sons - 2008 - 7th Edition*
2. *Saad M. A. - 'Thermodynamics: Principles and Practice' - Prentice Hall, New Jersey - 1998 - 2nd Edition*
3. *John R. Howell and Richard D. Buckius - 'Fundamentals of Engineering Thermodynamics' - McGraw Hill - 1987 - International Edition*

15MEC202 MACHINE DRAWING 2 0 2 3

1. DRAWING STANDARDS

Code of practice for Engineering Drawing, BIS specifications - Welding symbols, riveted joints, keys, fasteners – Reference to handbook for the selection of standard components like bolts, nuts, screws, keys etc.

2. 2-D DRAWINGS

Limits, Fits – Tolerancing of individual dimensions - Specification of Fits - Manual, Preparation of production drawings and reading of part and assembly drawings.

3. CAD PRACTICE (USING APPLICATION PACKAGES)

Drawing, Editing, Dimensioning, Plotting Commands, Layering Concepts, Hatching, Detailing, Assembly, basic principles of GD & T (geometric dimensioning & tolerance).

4. ASSEMBLY DRAWING (MANUAL & USING APPLICATION PACKAGES)

Manual parts drawing and preparation of assembled views given part details for components followed by practicing the same using CAD packages.

5. PREPARATION OF BILL OF MATERIALS AND TOLERANCE DATA

SUGGESTED ASSEMBLIES:

Detailed drawings of following machine parts are given to students to assemble and draw the sectional or plain elevations / plans / and side views with Dimensioning and bill of materials.

Sleeve & Cotter joint, Spigot & Cotter joint, Knuckle joint, Stuffing Box, Screw Jack, Foot step bearing, Universal Coupling, Plummer Block, Swivel Bearing, Simple Eccentric, Machine Vice, Protected type flanged coupling, Connecting Rod, Tail Stock.

TEXTBOOKS:

1. *K. L. Narayana - 'Machine Drawing' - New Age International publishers - 2010 - 4th Edition*
2. *K. C. John - 'Textbook of Machine Drawing' - PHI - 2009 - 1st Edition*

REFERENCE BOOKS:

1. *Junnarkar N. D. - 'Machine Drawing' - Pearson Education - 2004*
2. *P. S. Gill - 'A Textbook of Machine Drawing' - S.K. Kataria & Sons - 2013 Edition*
3. *N. D. Bhat, V M Panchal - 'Machine Drawing' - Charotar Publication House - 2014*
4. *R. K. Dhawan - 'A Textbook of Machine Drawing' S. Chand - 2nd Revised Edition*

15MEC203 MATERIAL SCIENCE AND METALLURGY 3 0 0 3

Unit 1

Structure of Crystalline Solids - Interatomic Bonding - Crystal Systems - UNIT cells - Metallic Crystal Structures - Miller indices - Crystallographic planes and directions - Linear and Planar Atomic Densities - Imperfections in Solids: Point – Linear - Interfacial defects.

Elastic, Anelastic and Plastic behaviour. Mechanical properties - stress-strain curves for ductile and brittle alloys. Ductility – Resilience -toughness. Hardness testing. Dislocations and plastic deformation. Slip phenomenon. Slip in single crystals.

Unit 2

Strengthening mechanisms - grain boundary hardening, solution hardening, work hardening. Ductile and Brittle Fracture - fracture mechanics. Impact testing. Ductile - brittle transition. Fatigue and creep properties. S-N Curves Fatigue and creep testing.

Constitution of alloys-solid solution, intermetallic compound, Hume-Rothery rule. Phase diagram-phase rule, lever principle, isomorphous, eutectic, peritectic and eutectoid reactions. Iron-Carbon phase diagram, equilibrium and non-equilibrium cooling in solid state, isothermal transformation, martensite and bainite reactions.

Unit 3

Heat treatment of steels: annealing, normalizing, hardening and tempering. Heat treatment of tool and die steels. Hardenability, its testing and simple problems related to materials selection. Surface hardening of steels - carburizing, nitriding, carbo-nitriding, induction method.

Classification of cast iron and steels - properties, microstructures and uses of cast irons, plain carbon, alloy, stainless, heat resistant, tool and die steels. Composition, properties, microstructures and uses of non-ferrous alloys - brass, bronze, aluminium, magnesium, nickel and zinc alloys.

TEXTBOOK:

Calllister W. D. - 'Materials Science and Engineering' - John Wiley & Sons – 2010 - 8th Edition

REFERENCES:

1. *Avner S. H. - 'Physical Metallurgy' – McGraw Hill Education – 2000 - 2nd Edition*
2. *Shackelford J. F. - 'Introduction to Materials Science for Engineers' - Prentice Hall 2014 - 8th Edition*
3. *Javed Hashemi, Smith F. W. - 'Foundations of Materials Science and Engineering' – McGraw Hill Education - 2010 - 5th Edition.*
4. *Dieter G. E. - 'Mechanical Metallurgy' - TATA McGraw Hill - 2013 - 3rd Edition.*

15MEC204 MECHANICS OF SOLIDS 3 0 0 3

Unit 1

Simple Stress and Strain

Introduction, Properties of Materials, Stress, Strain, Hook's law, Poisson's Ratio, Stress – Strain Diagram for structural steel and nonferrous materials, Principles of superposition, Total elongation of tapering bars of circular and rectangular cross sections. Elongation due to self – weight, Thermal stresses.

Composite section, Volumetric strain, expression for volumetric strain, Elastic constants, relationship among elastic constants, Thermal stresses (including thermal stresses in compound bars). Strain Energy & Impact loading.

Compound Stresses

Introduction, Stress components on inclined planes, General two-dimensional stress system, Principal planes and stresses and Mohr's circle of stresses.

Unit 2

Torsion of circular shafts

Introduction – Pure torsion-torsion equation of circular shafts, Strength and stiffness, Torsional rigidity and polar modulus, Power transmitted by shaft of solid and hollow circular sections.

Bending moment and shear force in beams

Introduction, Types of beams loadings and supports, Shearing force in beam, Bending moment, Sign convention, Relationship between loading, shear force and bending moment, Shear force and bending moment equations, SFD and BMD with salient values for cantilever beams, simply supported beams and overhanging beams considering point loads, UDL, UVL and Couple. Bending and shear stresses in beams.

Unit 3

Deflection of beams

Introduction – Definitions of slope, deflection, Elastic curve-derivation of differential equation of flexure, Sign convention Slope and deflection for standard loading classes using Macaulay's method for prismatic beams and overhanging beams subjected to point loads, UDL and Couple.

Thick and Thin Cylinders and shells

Analysis of thincylindrical shells and analysis of thick cylindrical shells using Lame's equation.

Elastic stability of columns

Introduction – Short and long columns, Euler's theory on columns, Effective length slenderness ration, radius of gyration, buckling load, Assumptions, derivations of Euler's Buckling load for different end conditions, Limitations of Euler's theory, Rankine's formula and problems.

TEXTBOOKS:

1. *R. C. Hibbeler, - 'Mechanics of Materials' - Prentice Hall - 2013 - 9th Edition*
2. *James M. Gere -'Mechanics of Materials' - CENGAGE Learning Custom Publishing - 2012 - 8th Edition*

REFERENCES:

1. *Ferdinand Beer & Russell Johnstan - 'Mechanics of Materials' - TATA McGraw Hill - 2003 - S.I. Units*
2. *Egor.P. Popov - 'Engineering Mechanics of Solids' - Pearson Edu. India - 1998 - 2nd Edition*
3. *Mubeen - 'Mechanics of Solids' - Pearson India - 2012 - 2nd Edition,*
4. *W. A. Nash, Schaum's Outline Series - 'Strength of Materials' - 2007 - 4th Edition*

15MEC205 FLUID AND THERMAL ENGINEERING 3 0 2 4

Unit 1

Introduction to thermal and fluid Sciences. Thermodynamics: Basic concepts of thermodynamics – Energy - Energy transfer and general energy analysis - Properties of pure substances - Energy analysis of closed systems - Mass and energy analysis of control volumes.

Unit 2

Fluid mechanics: Introduction and properties of fluids - Fluid statics - Bernoulli and energy equations - Momentum analysis of flow systems - Internal flow - External flow - Drag and lift.

Unit 3

Heat transfer: Mechanisms of heat transfer - Steady heat conduction - Transient heat conduction - Forced convection - Natural convection - Radiation heat transfer.

TEXTBOOK:

Y. A. Cengel, J. M. Cimbala and R. H. Turner, "Fundamentals of Thermal-Fluid Sciences", McGraw-Hill, Fourth Edition, 2012.

REFERENCES:

1. *Zemansky, "Heat and Thermodynamics", McGraw Hill, seventh edition, 2006.*
2. *Ojha C. S. P., Berndtsson R., Chandramouli P. N., "Fluid Mechanics and Machinery", Oxford University Press, 2010.*

15MEC211 FLUID MECHANICS AND MACHINERY 4 0 0 4

Unit 1

Introduction and Basic concepts of Fluid Mechanics. Continuum assumption. Fluid properties such as density, specific volume, specific weight, specific gravity. Pressure, vapor pressure, cavitation, viscosity, Newton's law of viscosity. Models for non-Newtonian fluids. Surface Tension and capillarity. Coefficient of compressibility. Machnumber. Hydrostatics. Pressure distribution in a static fluid - Pascal's law and hydrostatic law. Absolute, gauge and vacuum pressures. Static pressure measurement. Manometry.

Hydrostatic Force on plane surfaces and curved surface.

Buoyancy. Archimedes principle. Stability of floating bodies, Meta centric height.

Eulerian and Lagrangian description of fluids, local and convective acceleration. Flow visualization – streamlines, streak lines, pathlines, time lines, contour and vector plots.

Flow kinematics - vorticity and rotationality.

Unit 2

Reynold's Transport Theorem. Governing equations for mass, linear and angular momentum and energy in the integral form. Applications of these equations. Laminar and turbulent flow regimes.

Bernoulli's equation. Limitations. Applications of Bernoulli's equation. Hydraulic and energy grade lines.

Major energy losses in pipes. Darcy Weisbach equation. Introduction to Moody's chart. Minor energy losses in pipes. Series and parallel pipe connections. Equivalent pipe.

Laminar flow in circular pipes - average and maximum velocities, shear stress distribution, Pressure drop computation - Hagen Poiseuille Law.

Flow rate measurement for closed conduits - Venturimeter, Orificemeter, Pitot tube, rotameter, other electrical and mechanical flow measuring systems.

Unit 3

Dimensional Analysis and modelling. Significance. Buckingham's Pi Theorem. Similitude, types of similitude. Model testing.

Classification of pumps. Positive displacement pumps. Reciprocating pumps. Centrifugal Pump: working principle. Characteristic curves. Pump selection. Velocity triangles. Pump performance parameters, performance curves. Cavitation, NPSH and specific speed.

Hydraulic turbines. Classification. Impulse and reaction machines - Pelton, Francis and Kaplan Turbines. Velocity Triangles. Performance characteristics.

TEXTBOOK:

Cengel Y. A. and Cimbala J. M. - 'Fluid Mechanics (Fundamentals and Applications)' - McGraw Hill, India - 2014 - 3rd Edition

REFERENCES:

1. *White F. M. - 'Fluid Mechanics' - McGraw Hill India Pvt. Ltd – 2011 - 7th Edition*
2. *Fox and McDonald - 'Fluid Mechanics' - John Wiley - 2013 - 8thEdition*
3. *Panton R. L. - 'Incompressible Flow' - Wiley India, 2013 - 4th Edition*

15MEC212 KINEMATICS OF MACHINES 3 0 2 4

Unit 1

Basics of Mechanisms

Definitions – Link, Kinematic pair, Kinematic chain, Mechanism and Machine - Degree of Freedom – Mobility - Kutzbach criterion (Gruebler's equation) - Grashoff's law - Kinematic Inversions of four-bar chain and slider crank chain - Mechanical Advantage - Transmission angle. Description of common Mechanisms - Offset slider mechanism as quick return mechanisms, Pantograph, Straight line generators (Peaucellier and Watt mechanisms), Steering gear for automobile, Hooke's joint, Toggle mechanism, Ratchets and escapements - Indexing Mechanisms, Steering gear mechanisms such as Davis and Ackermann Steering gear.

Unit 2

Kinematic Analysis

Analysis of simple mechanisms (Single slider crank mechanism and four bar mechanism) - Graphical Methods for displacement, velocity and acceleration, velocity and acceleration polygons, Instantaneous Centre of Velocity, Kennedy Theorem, Klein's Construction; Shaping machine mechanism - Coincident points – Coriolis acceleration, Analytical method of analysis of slider crank mechanism and four bar mechanism. Approximate analytical expression for displacement, velocity and acceleration of piston of reciprocating engine mechanism.

Unit 3

CAMS

Classifications - Displacement diagrams - Parabolic, Simple harmonic and Cycloidal motions - Graphical construction of displacement diagrams and layout of plate cam profiles - circular arc and tangent cams.

GEARS

Classification of gears - Gear tooth terminology - Fundamental Law of toothed gearing and involute gearing - Length of path of contact and contact ratio - Interference and undercutting - Gear trains - Simple, compound and Epicyclic gear trains - Differentials.

Unit 4 (Practicals)

- To study various types of kinematics links, pairs, chains and mechanisms
- To study inversions of a 4-Bar mechanism
- To study the inversions of single mechanism
- To study the inversions of double slider crank mechanism
- To plot joint angle, velocity and acceleration of coupler link against crank rotation for a four-bar mechanism.
- To plot slider displacement, velocity and acceleration of slider against crank rotation for slider crank mechanism
- To study various types of gears – helical, cross helical, worm, bevel gear, rack and pinion.
- To study various types of cam and follower arrangements.
- To Study various types of gear trains – Simple, Compound, reverted, Epicyclic and Differential.
- To Develop a prototype of a four-bar mechanism
- To Develop a prototype of a Geneva mechanism

TEXTBOOK:

Rattan S. S. - 'Theory of Machines' - McGraw Hill IndiaPvt. Ltd. - 2014 – 4th Edition

REFERENCES:

1. *Thomas Bevan - 'Theory of Machines' - CBS Publishers and Distributors - 2005 - 3rd Edition*

2. *Ghosh A. and Mallick A. K. - 'Theory of Mechanisms and Machines' - Affiliated East-West Press Pvt.Ltd. New Delhi - 2008.*
3. *Shigley J. E. and UickerJ. J. - 'Theory of Machines and Mechanisms' - Oxford Publishers - 2014 - SI units Edition*
4. *Rao J. S. and Dukkipati R. V. - 'Mechanism and MachineTheory' - New Age Publishers, New Delhi - 2008*
5. *John Hannah and Stephens R. C. - 'Mechanics of Machines' - 1999 - Viva low-Priced Student Edition*
6. *Sadhu Singh - 'Theory of Machines' - Pearson Education - 2011 - 3rd Edition*

15MEC213 MANUFACTURING PROCESS I 3 0 0 3

Unit 1

Metal casting processes: Introduction to Metal casting - Pattern, core and Mould making - Moulding, sand properties and testing - Principles of gating and riser design - Melting furnaces - Casting processes - sand, die, gravity, centrifugal castings, shell mould and Investment casting. Fettling and cleaning of casting - Inspection of casting and Casting defects.

Unit 2

Metal forming processes: mechanics of forming processes and forming operations – rolling, forging, drawing, deep drawing, bending, extrusion, punching and blanking – high energy forming processes – defects in metal forming – problems.

Unit 3

Metal joining processes: Principles of welding – fusion, resistance and solid state welding – soldering, brazing and adhesive bonding, arc welding, resistance welding, gas welding, thermit welding, ultrasonic welding, electron beam welding, laser beam welding and explosive welding – weld defects and inspection.

Powder metallurgy - production of metal powders - characteristics of metal powders - compaction - sintering – applications.

Surface modification processes - diffusion coating – electroplating – anodizing - conversion coating - hot dipping - ceramic and diamond coating.

TEXTBOOK:

Serope Kalpakjian and Steven R. Schmid – 'Manufacturing Engineering and Technology' - Prentice Hall - 2013 - 7th Edition

REFERENCES:

1. *Roy A. Lindberg - 'Processes and Materials for Manufacture' - Prentice Hall of India Private limited - 2000*

2. *Dieter G. E. - 'Mechanical Metallurgy' - Tata McGraw Hill - 2013 - 3rd Edition*
3. *Amitabh A. Ghosh and Asok Kumar Maltil - 'Manufacturing Science' - Affiliated East-West, Press Private Limited - 2010*

15MEC230 AIRCRAFT SYSTEMS AND ENGINEERING 3 0 0 3

Unit 1

Aircraft industry overview: Evolution and history of light, Types of Aerospace industry, Key Players in aerospace Industry, Aerospace Manufacturing, Industry supply Chain, Prime Contractors, Tier 1 Suppliers, Key Challenges in Industry Supply Chain, OEM Supply Chain Strategies, Mergers and Acquisitions, Aerospace Industry Trends, Advances in Engineering / CAD / CAM / CAE Tools and Materials Technology, Global and Indian Aircraft Scenario.

Introduction to Aircrafts: Basic Components of an Aircrafts, Structural Members, Aircraft Axis System, Aircraft Motions, Control Surfaces and High Lift Devices.

Types of Aircrafts - Lighter than Air / Heavier than Air Aircrafts. Conventional Design Configurations based on Power Plant Location, Wing Vertical Location, Intake Location, Tail Unit Arrangements, Landing Gear Arrangements. Unconventional Configurations - Biplane, Variable Sweep, Canard Layout, Twin Boom Layouts, Span Loaders, Blended Body Wing Layout, STOL and STOVL Aircraft, Stealth Aircraft. Advantages and Disadvantages of this Configuration.

Unit 2

Introduction to Aircraft Systems: Types of Aircrafts Systems. Mechanical Systems. Electrical and Electronic System. Auxiliary Systems.

Mechanical System: Environmental Control Systems (ECS), Pneumatic Systems, Hydraulic Systems, Fuel Systems, Landing Gear Systems, Engine Control Systems, Ice and Rain Protection Systems, Cabin Pressurization and Air Conditioning Systems, Steering and Break Systems, Auxiliary Power unit.Mechanical Systems: Avionics, Flight Controls, Autopilots and Flight Management Systems, Navigation Systems, Communication, Information Systems, Radar Systems.

Unit 3

Basic Principles of Flight: Significance of Speed of Sound, Air Speed and Ground Speed, Properties of Atmosphere, Bernoulli`s Equation, Forces on the Air Plane, Air Flow Over the Wing Section, Pressure Distribution over a wing Section, Generation of Lift, Drag, Pitching Moments, Types of Drag, Lift Curve, Drag Curve, Lift / Drag Ratio Curve, Factors affecting Lift and Drag,Center of Pressure and it's Effects. Aerofoil Nomenclature, Types of Aerofoil, Wing Section - Aerodynamic Center, Aspect Ratio, Effects of Lift, Drag, Speed, Air Density on Drag.

Basics of Flight Mechanics: Mach Waves, Mach Angles, Sonic and Supersonic Flight and its Effects. Stability and Control: Degree of Stability – Lateral, Longitudinal and Directional Stability and Controls of Aircraft. Effects of Flaps and Slats on Lift Coefficients, Control Tabs, Stalling, Landing, Gliding Turning, Speed of Sound, Mach Numbers, Shock Waves. Aircraft Performance and Maneuvers: Power Curves, Maximum and Minimum Speeds of Horizontal Flight, Effects of Changes of Engine Power, Effects of Altitude on power Curve, Forces Acting on an Aeroplane during a Turn, Loads during a Turn, Correct and Incorrect Angles of a Bank, Aerobatics, Inverted Maneuvers, Maneuverability.

TEXTBOOKS:

1. *Kermode A. C. - 'Flight without Formulae' - Pearson Education - 2008 - 5th Edition*
2. *Kermode A. C. – 'Mechanics of Flight' - Pearson Education - 2012 - 12th Edition*

REFERENCES:

1. *Shevell - 'Fundamentals of Flight' - Pearson Education - 1988 - 2nd Edition*
2. *John D. Anderson - 'Introduction to Flight' - McGraw Hill - 2005*
3. *Ian Mior and Seabridge A. - 'Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration' - Wiley - 2008*

15MEC231 AUTOMOTIVE CHASSIS DESIGN 3 0 0 3

Unit 1

Clutch Design Calculation: Design of single plate clutch, multi plate clutch, design of centrifugal clutch, cone clutch, energy dissipated, torque capacity of clutch, design of clutch components, design details of roller and sprag type of clutches.

Gear Box: Performance of vehicle, total resistance to motion, traction and tractive effort, acceleration, calculation of gear ratio, design of three speed gear box, design of four speed gear boxes.

Unit 2

Vehicle Frame and Suspension: Study of loads, moments and stresses on frame members, computer aided design of frame for passenger and commercial vehicles, computer aided design of leaf springs, coil springs and torsion bar springs.

Unit 3

Front Axle and Steering Systems: Analysis of loads, moments and stresses at different sections of front axle, determination of loads at kingpin bearings, wheel spindle bearings, choice of bearings, determination of optimum dimensions and proportions for steering linkages ensuring minimum error in steering.

Final Drive and Rear Axle: Design of propeller shaft, design details of final drive gearing, design details of full floating, semi-floating and three quarter floating rear shafts and rear axle housings.

TEXTBOOK:

Heldt P. M. - 'The Automotive Chassis' - Literary Licensing – 2012.

REFERENCES:

1. *Steeds W. 'Mechanics of Road Vehicles' - Illiffe Books Ltd., London -1990*
2. *Giles J. G. - 'Steering, Suspension and Tyres' - Illiffe Books Ltd., London - 1988*
3. *Steeds N. and Garret - 'Motor Vehicle' - Illiffe Books Ltd., London - 2000*
4. *Giri N. K. - 'Automobile Mechanics' - Khanna Publisher, New Delhi - 2002*
5. *Heldt P. M. - 'Torque Converter' - Chilton Book Co., New York -1982*
6. *Averns D. - 'Automobile Chassis Design' - Illiffe Books Ltd. – 1992*

15MEC232 AUTOMOTIVE TECHNOLOGY 3 0 0 3

Unit 1

Vehicle and Engine Construction - Chassis, Frame and Body Construction, Engine Types, Construction Details and multi-cylinder engines, Valve Arrangements, Valve Drives, Engine Cooling and Lubrication, Air Supply System, Carburetors, Electronic Fuel Injection Systems, Exhaust Systems.

Power Drive Line: Clutch - Types and Construction, Fluid Coupling, Transmissions - Manual, Semi and Automotive Transmission, Continuously Variable Transmission, Overdrives, Torque Converter, Propeller Shaft, Differential and Axles, Front and All Wheel Drive Vehicles.

Unit 2

Running Systems: Steering Geometry and Types, Steering Linkages, Power and Power Assisted Steering, Types of Front Axle, Suspension Systems, Suspension Design Consideration Active Suspension, Braking Systems - Hydraulic, Pneumatic Brakes and Power Brakes, Anti-Lock Brake system - Wheels and Tyres, Electrical and Electronic Systems: Electrical Systems – Storage, Charging, Starting and Ignition and Lighting Systems, Electronic Controls for Engine and Vehicle Body, Electronic Dashboard Instruments, Electronic and Computer Controlled Transmissions, Intelligent Transportation Systems. Onboard diagnosis system, Safety and Security systems.

Unit 3

Performance of Automobiles: Design Aspects - Ergonomics, Seating and Packaging, Vehicle Body Aerodynamics, Forces and Couples, Traction and Tractive Effort, Power for Propulsion, Cornering Properties, Stability of Vehicle, Dynamics of Vehicles.

Future Automobiles: Automobile Air Pollution, Pollution Control Norms, Alternate Power Units for Automobiles - Use of Natural Gas, LPG and Hydrogen in Automobiles as Fuels, Fuel Cells, Electric and Hybrid Vehicles. Indian Traffic Rules.

TEXTBOOKS:

1. *Heisler H. - 'Advanced Engine Technology' - SAE - 2012*
2. *William H. Crouse, Donald Anglin – 'Automotive Mechanics' - McGraw Hill Education (India) Private Limited- 2006 - 10th Edition*

REFERENCES:

1. *Garrett T. K., Newton K., and Steeds W. - 'Motor Vehicles' - Butterworth Heinemann - 2001*
2. *Fenton J. - 'Handbook of Automotive Body and System Design' - Professional Engineering Publishing, UK - 2005*
3. *Giri N. K. - 'Automobile Mechanics', Khanna Publishers, New Delhi - 2006 - 8th Edition*
4. *Bishop R. - 'Intelligent Vehicle Technology and Trends' - AR Tech House Inc. - 1999*

15MEC233 CONDITION MONITORING AND DIAGNOSTIC MAINTENANCE 3 0 0 3

Unit 1

Basic Concepts: Machinery failures, basic maintenance strategies, factors influencing maintenance strategies, machine condition monitoring, transducer selection and location, PC interfacing and virtual instrumentation. Vibration signatures of faults in rotating and reciprocating machines; detection and diagnosis of faults.

Unit 2

Instrumentation and Signal Processing: Types of sensors in condition monitoring: vibration, acoustics and noise, acoustic emission, temperature, ultrasonic and infra-red sensors - Signal processing: basic signal and systems concepts, time domain analysis, frequency domain analysis, time-frequency analysis, wavelets and wavelet packets.

Unit 3

Pattern Recognition: Feature extraction and feature selection methods, feature reduction using PCA - discriminant functions and decision boundaries, decision trees, maximum likelihood and nearest neighbour classification - Bayesian theory, neural networks, fuzzy logic and support vector machines (SVM) in classification.

Application and case studies of condition monitoring: Bearings, gear boxes, engines, structural health monitoring, machine tool condition monitoring etc.

TEXTBOOKS:

1. *Balageas D., Fritzen C P. and Guemes A. - 'Structural Health Monitoring' - Published by ISTE Ltd., USA - 2006*

2. Clarence de Silva - 'Vibration and Shock Handbook'- CRC Taylor & Francis - 2005

REFERENCE BOOKS:

1. Collacot - 'Mechanical Fault Diagnosis and Condition Monitoring'- Chapman - Hall - 1987
2. Davies - 'Handbook of Condition Monitoring - Techniques and Methodology' – Springer -1998
3. Norton M. and Karczub D. – 'Fundamentals of Noise and Vibration Analysis for Engineers' – Cambridge University Press - 2003 - 2nd Edition
4. Duda R. O., Peter Hart E., and Stork D. E. - 'Pattern Classification' - Wiley India - 2007 - 2nd Edition
5. Strang G. and Nguyen T. - 'Wavelets and Filter Banks' - Wellesley-Cambridge Press -1996

15MEC234 DESIGN FOR MANUFACTURE AND ASSEMBLY 3 0 0 3

Unit 1

Design Impact on Cost, Design for "X" - DFM approach, DFM Framework, Material and Process Evaluation, General DFM Guidelines, Machining and Casting Guidelines and Examples, Minimize Finishing Requirements. Computer applications for DFMA.

Design features to facilitate machining: datum features - functional and manufacturing. Component design - machining considerations, redesign for manufacture, examples. Form design of castings and weldments.

Unit 2

Tolerance Analysis: Process capability, process capability metrics, Tolerance - cost aspects, feature tolerances, geometric tolerances, relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerances - sure fit law, normal law and truncated normal law.

Interchangeable part manufacture and selective assembly - control of axial play - introducing secondary machining operations, laminated shims - examples.

Unit 3

Datum Systems: Degrees of freedom, grouped datum systems - computation of translational and rotational accuracy - geometric analysis and applications.

True Position Theory: Co-ordinate and conventional method of feature location, tolerance and true position tolerance, virtual size concept, floating and fixed fasteners, projected tolerance zone, assembly with gasket, zero true position tolerance, functional gauges, paper layout gauging - examples.

Principles of Design for Assembly, Minimize Part Count, Standardization and Minimize Part Variety, Design guidelines for manual assembly, DFA analysis, DFA index, Design for Automated Assembly. Introduction to usage of DFMA software.

TEXTBOOKS:

1. Boothroyd G., Dewhurst P. and Knight W. - 'Product Design for Manufacture and Assembly' - Marcel Dekker, New York - 2012 - 4th Edition
2. Peck H. - 'Designing for Manufacture' - Pitman Publications - 1983

REFERENCES:

1. Spotts M. F. - 'Dimensioning and Tolerance for Quantity Production'- Prentice Hall Inc. -1983
2. Wade O. R. - 'Tolerance Control in Design and Manufacturing' - Industrial Press Inc., New York - 1967
3. Creveling C. M. - 'Tolerance Design - A Hand Book for Developing Optimal Specifications' - Addison Wesley Longman, Inc, - 1997

15MEC235 FRACTURE MECHANICS 3 0 0 3

Unit 1

Introduction to Fracture Mechanics: Failures in structures - types and causes, historical perspective, fracture mechanics approach to design -energy criterion, stress intensity approach, time dependent crack growth and damage tolerance, effect of material properties on fracture.

Linear Elastic Fracture Mechanics (LFEM): Stress concentration effect of flaws, Griffith energy balance, the energy release rate, instability and resistance curve(R-curve), stress analysis of cracks, relationship between stress intensity factor and energy release rate (K and G), crack tip plasticity, mixed mode crack initiation and propagation.

Unit 2

Elastic Plastic Fracture Mechanics (EPFM): Crack-Tip-Opening Displacement (CTOD), the J contour integral and its determination, relationships between J and CTOD, crack-growth resistance curves, J-controlled fracture.

Fracture mechanism in metals and non-metals: Ductile fracture, cleavage, the ductile-brittle transition, intergranular fracture, fracture in polymeric materials, and fracture in ceramic and ceramic composites.

Unit 3

Applications: Introduction to fracture toughness testing of metals and non-metals for determination of fracture parameters, Application of fracture mechanics concepts in the analysis of fatigue crack growth.

Computational fracture mechanics: Overview of numerical methods for fracture mechanics problems, traditional methods in computational fracture mechanics – point matching and energy methods, the energy domain integral, finite element

implementation, design of finite element mesh, linear elastic convergence study, analysis of growing cracks.

TEXTBOOK:

Anderson T. L. - 'Fracture Mechanics: Fundamentals and Applications' - CRC Press - 2012 - 5th Edition

REFERENCES:

1. *Ramesh K. - 'E-book on Engineering Fracture Mechanics' - IIT Madras - 2006*
2. *Janssen M., Zuidema and Wanhill R. J. H. – 'Fracture Mechanics' - VSSD (Delft University of Technology) - 2006 - 2nd Edition*
3. *Kumar P. - 'Elements of Fracture Mechanics' - Wheeler Publishing - 1999*
4. *Dahlberg T. and Ekberg S. - 'Failure Fracture Fatigue: An Introduction' - Overseas Press (India) - 2006*
5. *Suresh S. - 'Fatigue of Materials' - Cambridge University Press - 1998 - 2nd Edition*

15MEC236 MATERIALS SELECTION IN MECHANICAL DESIGN 3 0 0 3

Unit 1

Overview of materials properties - modulus, tensile. Fatigue, creep strengths, toughness, hardness, fracture toughness, damping capacity, thermal, oxidation, corrosion and wear resistances.

Materials property charts. Materials families and classes - metals, ceramics, glasses, polymers, elastomers, composites, foams, natural.

Unit 2

Basis of materials selection. Design of components - functions, constraints, objectives and free variables. Selection process - translation, screening, ranking, supporting information. Illustration of the principles with examples - heat sink, overhead electrical transmission line, tie rod, light stiff beam. Multiple constraints and objectives - case studies. Design of hybrid materials - case studies.

Unit 3

Case studies in materials selection for various applications - oar, table leg, flywheel, kiln walls, passive solar heating, heat exchangers, bearings, springs, pressure vessel.

Principles of process selection and classification - casting, forging, moulding, fabrication, welding, joining, machining, powder processing, composite processing. Illustration of the principles with case studies.

Multiple constraints and objectives - case studies.Design of hybrid materials - case studies.

TEXTBOOK:

Ashby M. F. - 'Materials selection in mechanical design' - Butterworth Heinemann - 2010 - 3rd Edition

REFERENCE:

ASM Handbook - 'Materials Selection and Design' - 1997

15MEC237 MECHATRONICS 3 0 0 3

Unit 1

Introduction to Mechatronics systems - Measurement Systems - Control Systems - Micro Processor based controllers. Sensors and Transducers - Displacement, Position and Proximity; Velocity, Motion, Force, Fluid Pressure, Liquid flow and Liquid level Temperature, Light sensors - selection of sensors. Pneumatic and Hydraulic actuation systems – Directional Control Valves - Rotary Actuators. Mechanical Actuation Systems – Cams – Gear Trains – Ratchet and pawl – Belt and Chain Drives – Bearings.

Unit 2

Electrical Actuation Systems – Mechanical Switches – Solid State Switches – Solenoids – D.C Motors – A.C Motors – Stepper Motors. Building blocks of Mechanical, Electrical, Fluid and Thermal Systems, Rotational – Transnational Systems, Electromechanical Systems – Hydraulic – Mechanical Systems. Continuous and discrete process Controllers – Control Mode – Two – Step mode – Proportional Mode – Derivative Mode – Integral Mode – PID Controllers – Digital Controllers – Velocity Control – Adaptive Control – Digital Logic Control – Micro Processors Control.

Unit 3

Programmable Logic Controllers – Basic Structure – Input / Output Processing – Programming – Mnemonics – Timers, Internal relays and counters – Shift Registers – Master and Jump Controls – Data Handling – Analogs Input / Output – Selection of a PLC Problem. Stages in designing Mechatronics Systems – Traditional and Mechatronic Design - Possible Design Solutions. Case Studies of Mechatronics Systems, Pick and place robot – automatic Car Park Systems – Engine Management Systems.

TEXTBOOK:

W. Bolton - 'Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering' - Prentice Hall - 2013 - 5th Edition

REFERENCES:

1. *Michael B. Histand and David G. Alciatore - 'Introduction to Mechatronics and Measurement Systems', McGraw Hill - 2000 - International Editions*

2. *Bradley D. A., Dawson D., Buru N.C. and. Loader A.J - 'Mechatronics' - Chapman and Hall - 1993*
3. *Dan Necsulesu - 'Mechatronics' - Pearson Education Asia - 2002*
4. *Lawrence J. Kamm - 'Understanding Electro : Mechanical Engineering - An Introduction to Mechatronics' - Prentice Hall of India Pvt, Ltd. - 2000*
5. *Nitaigour Premchand Mahadik - 'Mechatronics' - Tata McGraw Hill Publishing Company Ltd. - 2003*

15MEC238 MICRO-ELECTRO MECHANICAL SYSTEM 3 0 0 3

Unit 1

Definition of MEMS. MEMS devices. Silicon as a MEMS material - mechanical properties of silicon. Mechanical components in MEMS. Design concepts of mechanical components. Working Principles of Microsystems. Engineering Science for Microsystems design and Fabrication. Scaling laws – Scaling in geometry, rigid body dynamics, electrostatic forces, electromagnetic forces, electricity-fluid mechanics and heat transfer.

Unit 2

Materials for MEMS and Microsystems. Fabrication technologies – Photolithography - Ion implantation – diffusion – oxidation – CVD - Physical Vapor Deposition – Etching.

Micro manufacturing - Bulk and surface micro machining - LIGA.

Unit 3

Microsystems Design - Design considerations - Process design - Mechanical Design – CAD - Micro system packaging – Levels – Bonding – Interfaces - Assembly – Selection of Packaging Materials.

TEXTBOOK:

Tai–Ran Hsu - 'Mems & Microsystems Design and Manufacturing' - John Wiley & Sons - 2008 - 2nd Edition

REFERENCES:

1. *Marc J Madou - 'Fundamentals of Microfabrication' - CRC Press - 2002 - 2nd Edition*
2. *Mohamed Gad-el-Hak – 'The MEMS Handbook' - CRC Press - 2002*

15MEC239 MODELING AND SIMULATION OF ENGINEERING SYSTEMS 3 0 0 3

Unit 1

Fundamental Concepts in Mathematical Modelling: Abstraction – linearity and superposition – balance and conservation laws and the system – boundary approach.

Lumped – Element Modeling: Mechanical systems - Translational, rotational. Hydraulic systems. Thermal systems. RLC Electrical Systems.

Modeling of First–order and Second–order Systems: Governing equations for free and forced responses – transient response specifications – experimental determination – Laplace transform. Time Domain, Frequency Domain and State Space.

Unit 2

Frequency response of Linear, Time invariant systems – frequency response of first–order and second–order systems – state space formulations of systems problems relating frequency response to pole location – transient response-poles and frequency response.

Unit 3

Feedback systems: Systems with feedback – block diagrams – properties of feedback systems – relative stability - phase and gain margins.

TEXTBOOK:

Cha P. D., Rosenberg J. J. and Dym C. L. - 'Fundamentals of Modeling and Analyzing Engineering Systems'- Cambridge University - 2000

REFERENCES:

1. *Woods Robert L. and Kent L.- 'Modeling and Simulation of Dynamic Systems'- Prentice Hall - 1997*
2. *Mukherjee A. and Karmakar R. - 'Modeling and Simulation of Engineering Systems through Bondgraphs' - Narosa - 2000*
3. *Frederick C. - 'Modeling and Analysis of Dynamic Systems' - Wiley - 2001 - 3rd Edition*

15MEC240 OPTIMIZATION TECHNIQUES IN ENGINEERING 3 0 0 3

Unit 1

Introduction to Optimization: Engineering application of Optimization – Statement of an Optimization problem - Optimal Problem formulation - Classification of Optimization problem. Optimum design concepts: Definition of Global and Local optima – Optimality criteria - Review of basic calculus concepts – Global optimality.

Linear programming methods for optimum design: Review of Linear programming methods for optimum design – Post optimality analysis - Application of LPP models in design and manufacturing.

Unit 2

Optimization algorithms for solving unconstrained optimization problems – Gradient based method: Cauchy's steepest descent method, Newton's method, Conjugate gradient method.

Optimization algorithms for solving constrained optimization problems – direct methods – penalty function methods – steepest descent method - Engineering applications of constrained and unconstrained algorithms.

Unit 3

Modern methods of Optimization: Genetic Algorithms - Simulated Annealing - Ant colony optimization - Tabu search – Neural-Network based Optimization – Fuzzy optimization techniques – Applications. Use of Matlab to solve optimization problems.

TEXTBOOK:

Rao S. S. - 'Engineering Optimization, Theory and Practice' - New Age International Publishers - 2012 - 4th Edition

REFERENCES:

1. *Deb K. - 'Optimization for Engineering Design Algorithms and Examples' – PHI - 2000*
2. *Arora J. - 'Introduction to Optimization Design' - Elsevier Academic Press, New Delhi - 2004*
3. *Saravanan R. - 'Manufacturing Optimization through Intelligent Techniques' - Taylor & Francis (CRC Press) - 2006*
4. *Hardley G. -'Linear Programming' - Narosa Book Distributors Private Ltd. - 2002*

15MEC241 PRESSURE VESSEL DESIGN 3 0 0 3

Unit 1

Introduction to Pressure Vessels, Design Philosophy, Structural Integrity - Failure modes and theories - Working loads and allowable stresses - Fatigue, fracture and buckling.

Stress categorization - Primary, secondary and peak.

Design of Cylindrical Shells - ASME equations - Thin shell equations - Thick shell equations - Buckling of cylindrical shells.

Unit 2

End Closures - ASME equations for various types of heads – Hemispherical, flat, ellipsoidal, torispherical, and conical heads.

Discontinuity Stresses - Discontinuity stresses - Beams on elastic foundation, Cutouts and Reinforcements – Stress concentrations around a hole – Reinforcements.

Fatigue Assessment - Exemption from fatigue analysis - S-N curves - Design curves - Cumulative damage - Fatigue evaluation.

Unit 3

Bolted Flanges - RF and FF flanges - Gasket loading behavior - Application of ASME equations for flange analysis and bolt design.

Design of Supports - Lug support - Support skirts - Saddle support.

TEXTBOOKS:

1. *Harvey J. F. - 'Theory and Design of Pressure Vessels' - Van Nostrand - 1991*
2. *Chattopadhyaya S. - 'Pressure Vessels - Design and Practice' - CRC Press - 2005*

REFERENCES:

1. *Brownell and Young -Process Equipment Design' - Wiley Publishing Ltd. - 1959*
2. *Ellenberger P. - 'Pressure Vessels: ASME Code Simplified' - McGraw Hill Company - 2004 - 8th Edition*

15MEC242 THEORY OF ELASTICITY 3 0 0 3

Unit 1

Analysis of Stress and Strain: Stress at a point; stress tensor; stress transformations; principal stresses; octahedral stress; geometrical representation of stress at a point; equations of equilibrium.

Infinitesimal affine transformation for deformation; strain tensor; principal strains; strain-displacement relations for finite and infinitesimal strains; compatibility conditions. Constitutive Equations:General theory; generalized Hooke's law for anisotropic and isotropic materials.

Unit 2

Equations of Elasticity: Common equations of elasticity theory like Mitchel-Beltrami and Navier equations, formulation of the general elasticity problem; boundary conditions.

Unit 3

Solution of Some Special Boundary Value Problems: Simplifications; two-dimensional problems in rectangular and polar coordinates; Airy's stress function; a few problems like stress concentration around a circular hole and Boussinesq problem.

A few representative three-dimensional problems; torsion and bending of non-circular prismatic bars (Saint-Venant's solution); membrane analogy, Simple Plate bending.

TEXTBOOKS:

1. *Timoshenko S. P. and Goodier J. N. - 'Theory of Elasticity'- McGraw Hill International Editions, 1970 - 3rd Edition*

2. L. S. Srinath - 'Advance Mechanics of Solids' - McGraw Hill Education - 2009 - 3rd Edition

REFERENCES:

1. Hartog, J. P. D. - 'Advanced Strength of Materials'- Dover Publications Inc, - 1987
2. Boresi A. P., Schmidt R. J. and Sidebottom O. M. - 'Advanced Mechanics of Materials' - John Wiley & Sons Inc. - 1993 - 5th Edition
3. Durelli A. J., Phillips E. A. and Tsao C. H. - 'Introduction to the Theoretical and Experimental Analysis of Stress and Strain' – McGraw Hill, New York - 1958.

15MEC243 TOOL DESIGN 3 0 0 3

Unit 1

Design of Jigs: Introduction - Location Principles – Six Point Location Principle – Locators – Clamping Principles – Clamping Devices – Drill Jigs – Drill Bushes – Drill Jig Types – Design and Development of Jigs for given components.

Unit 2

Design of Fixtures: Milling Fixtures – Milling Methods – Milling Fixture Types – Turning fixtures – Broaching Fixtures – Grinding Fixtures – Assembly, Inspection and Welding Fixtures – Modular Fixtures – Design and Development of Fixtures for given components.

Unit 3

Design of Dies: Power presses types and construction details, die cutting operation, cutting action in die and punch, center of pressure, clearance and its significance, cutting forces, methods of reducing cutting forces, methods of punch support, strippers, stock stops, guide pilots, knockout, design of blanking and piercing dies. Design Concepts and description of the components of progressive dies. Design of progressive dies. Design of compound dies. Design of combination dies.

Drawing Dies: Metal flow and factors affecting drawing, blank size calculations, drawing force, single and double acting drawing dies, design and development of drawing dies for different components.

Bending and Forming Dies: Spring back, bend allowance; calculation of development length, bending force calculations types of bending dies. Curling dies.

Forging process and forging dies. (Introductory Treatment)

TEXTBOOKS:

1. P. H. Joshi – 'Jigs and Fixtures Design Manual' - McGraw Hill - 2002
2. Kempster M. H. A. - 'An Introduction to Jig and Tool Design' - Viva Books Pvt. Ltd. - 2002
3. Paquin and Crowley – 'Die Design Fundamentals' - Industrial Press, New York – 1979

REFERENCE BOOKS:

1. John G. Nee - 'Fundamentals of Tool Design' - Society of Manufacturing - 1998 - 4th Edition
2. 'Production Techno1ogy Hand Book' - HMT - Tata McGraw Hill
3. E. K. Henriksen – 'Jig and Fixture Design Manual' - Industrial Press, New York - 1973
4. Donaldson, Lecain and Goold – 'Tool Design' - McGraw Hill, New York - 1976

15MEC246 AUTOMOTIVE ELECTRONICS 3 0 0 3

Unit 1

Introduction: Automotive component operation - Electrical wiring terminals and switching, Multiplexed wiring systems - Circuit diagrams and symbols. Charging Systems and Starting Systems: Charging systems principles alternations and charging circuits - New developments requirements of the starting system - Basic starting circuit.

Ignition systems: Ignition fundamentals, Electronic ignition systems. Programmed ignition distribution - direct ignition spark plugs. Electronic Fuel Control Basics of combustion - Engine fuelling and exhaust emissions - Electronic control of carburetion - Petrol fuel injection - Diesel fuel injection.

Unit 2

Instrumentation systems: Introduction to instrumentation systems - Various sensors used for different parameters sensing - Driver instrumentation systems - vehicle condition monitoring - trip computer different types of visual display.

Electronic control of braking and traction: Introduction - control elements and control methodology - Electronic control of Automatic Transmission: Introduction - Control of gear shift and torque converter lockup - Electric power steering - Electronic clutch.

Unit 3

Engine management systems: Combined ignition and fuel management systems - Exhaust emission control - Digital control techniques - Complete vehicle control systems - Artificial intelligence and engine management – use of microprocessor in Automotives.

Lighting and security systems: Vehicles lighting Circuits - Signaling Circuit Central locking and electric windows security systems - Airbags and seat belt tensioners - Miscellaneous safety and comfort systems.

TEXTBOOK

Denton T. - 'Automobile Electrical and Electronic Systems' - Edward Arnold Publications - 2001

REFERENCES

1. Knowles D. - 'Automotive Electronic and Computer controlled Ignition Systems' - Don, Prentice Hall, Englewood Cliffs, New Jersey - 1988

2. *William T. M. - 'Automotive Electronic Systems' - Heiemann Ltd., London - 1978*
3. *Ronald K. J. - 'Automotive Electronics Handbook' - McGraw Hill, Inc, - 1999*

15MEC247 COMBUSTION ENGINEERING 3 0 0 3

Unit 1

Thermodynamics of Combustion: Properties of mixtures - Combustion stoichiometry - Heat of reaction and formation - adiabatic flame temperature - chemical equilibrium.

Chemical Kinetics: Elementary reactions: Rate of reactions and their functional dependence - chain reactions, Pre-Ignition kinetics, Global reactions, Nitrogen Oxide kinetics, Soot kinetics.

Unit 2

Combustion of gaseous and vaporized fuels: Laminar premixed flames - laminar flame theory - Turbulent premixed flames - Mechanism of flame stabilization - Explosion limits - Mechanism of flame quenching - Flammability and ignition - diffusion flames - flame propagation - Gaseous combustion system.

Unit 3

Combustion of liquid fuels: Spray formation - size distribution - fuel injectors, spray dynamics - vapourisation of single droplets - spray combustion system.

Combustion of solid fuels: Solid fuel combustion mechanism - Drying of solid fuels - Devolitilisation of solid fuels - Fuel-bed combustion – suspension burning - fluidized bed combustion.

TEXTBOOKS:

1. *Borman G. L. and Ragland K. W. - 'Combustion Engineering' - McGraw-Hill - 2005*
2. *Turns S. R. - 'An Introduction to Combustion' – McGraw Hill - 1996*

REFERENCES:

1. *Kuo K. K. - 'Principles of Combustion' - John Wiley & Sons - 1984*
2. *Sharma S. P. and Chandramohan - 'Fuels and Combustion' - Tata McGraw Hill Publishing Company Limited - 1984*
3. *Heywood J. B. - 'Internal Combustion Engine Fundamentals' – McGraw Hill - 1993*

15MEC248 COMPUTATIONAL FLUID DYNAMICS 3 0 0 3

Unit 1

Introduction & conservation laws of fluid motion: Models of the fluid flow, Substantial derivative, Divergence of the velocity, Laws of Conservation - Continuity Equation, momentum Equation, Energy Equation, Dimensionless forms of Equations, Simplified Mathematical Model, Mathematical Classification of flows, Physical Boundary conditions.

Basics of numerics: Components of the Numerical solution Methods – Mathematical model, Discretization method, Co-ordinates and Basic Vector systems, Numerical Grid, Finite approximations, Solution Method, Convergence criteria. Properties of Numerical Solution Methods – Consistency, Stability, Convergence, Conservativeness, Boundedness, Realizability. Discretization Approaches – FEM, FDM, FVM.

Unit 2

Finite difference method: Approximation of the first Derivative – Taylor series expansion, Polynomial Fitting, Compact Schemes, Non-Uniform Grids. Approximation of the second derivative, Approximation of the mixed derivative, Explicit and Implicit approaches, Errors and Analysis of stability.

Spectral analysis and grid generation: Spectral Analysis of numerical Schemes, Higher order methods, High accuracy compact schemes. General transformation of the equations, Matrics and Jacobians, Stretched grids, Boundary fitted Co-ordinate systems, Elliptic grid generation, unstructured grids.

Unit 3

Computational heat transfer: Steady one & two dimensional heat conduction, Unsteady one-dimensional heat conduction, over-relaxation and under-relaxation. One dimensional steady convection and Diffusion.

Computational Fluid Flow: Solution methods for incompressible flows - collocated and staggered grid, Pressure correction equations, SIMPLE and SIMPLER Algorithm. Examples in simple geometries such as flow in channel, lid driven cavity flow and validation. Solution methods for compressible flows - Importance of conservation and upwinding. Simple artificial dissipation methods, pressure-correction methods for arbitrary Mach numbers. Applications to inviscid compressible flows.

TEXTBOOK:

1. *Ferziger J. H. and Peric M. - 'Computational Methods for Fluid Mechanics' - Springer - 2013 - 3rd Edition.*
2. *Anderson J. D. - 'Computational Fluid Dynamics: The Basics with applications' – McGraw Hill - 2007*

REFERENCES:

1. *Sengupta T. K. - 'Fundamentals of Computational Fluid Dynamics' - Universities Press - 2004*
2. *Patankar S. V. - 'Numerical Heat transfer and Fluid Flow' - Taylor & Francis Publications - 1980*

15MEC249 DESIGN OF THERMAL SYSTEMS 3 0 0 3

Unit 1

System Design Fundamentals: Basic design Principles - Workable and Optimal systems - Matching of system components - Economic analysis – Depreciation - Gradient present worth factor.

Mathematical Modeling for Simulation: Mathematical models, Principles, Types, Equation fitting, Information Flow Diagram, Workable Systems, Optimal Systems.

Unit 2

Modeling Thermal Equipment: Modeling of heat exchangers, evaporators, condensers, absorption and rectification columns, compressor, pumps - simulation studies - information flow diagram - solution procedures.

Unit 3

Thermal Systems Optimization: Objective function formulation - Constraint equations - Mathematical formulation - Calculus method - Dynamic programming - Geometric programming - Linear programming methods - solution procedures.

Dynamic Behaviour of Thermal System: Steady state simulation - Laplace transformation - Feedback control loops - Stability analysis - Non-linearities.

TEXTBOOKS:

1. *Stoecker W. F. - 'Design of Thermal Systems' – McGraw Hill -1980*
2. *Stoecker W. F. – 'Refrigeration and Air Conditioning' - Tata McGraw Hill Publishing Company Limited -1985*

REFERENCES:

1. *'ASHRAE Guide & applications' - ASHRAE, USA -1985*
2. *Fanger P. O. - 'Thermal Comfort' – McGraw Hill, USA - 1972*
3. *Kapur J. N. - 'Mathematical Modelling' - Wiley Eastern, New York - 1980*
4. *McQuiston F. C. and Parker T. D. - 'Heating, Ventilating and Air conditioning, Analysis and Design' - John Wiley, USA - 1988*

15MEC250 FLUID POWER DRIVES AND CONTROLS 3 0 0 3

Unit 1

Basic principles - Hydraulic Principles. Hydraulic Actuators – Linear, Rotary - Selection – Characteristics.

Hydraulic Valves: Pressure, Flow, Direction Controls - proportional control valve. Fluid power symbols. Hydraulic circuits: Reciprocating, Quick return, Sequencing, synchronizing and other industrial circuits etc.

Unit 2

Design of Hydraulic circuits: Selection and sizing of components - calculation of frictional head loss - equivalent length for various components - actuator load calculation - pump sizing.

Unit 3

Pneumatic system fundamentals: FRL, actuators and valves. Logic Circuits - Position - Pressure Sensing, switching, electro-pneumatic systems.

Design of Pneumatic circuits using Karnaugh maps. Cascade-Step counter. Combination methods.

PLC programming – Microprocessors - Principles of Low Cost Automation - Case studies.

TEXTBOOK:

Esposito A. - 'Fluid Power with Applications' - Pearson Education - 2005 - 5th Edition

REFERENCES:

1. *Michael J., Pinches and Ashby J. G. - 'Power Hydraulics' - Prentice Hall - 1989*
2. *Parr A. - 'Hydraulics and Pneumatics' – Jaico - 1999.*
3. *Pease D. A., and Pippenger J. A. - 'Basic Fluid Power' - Prentice Hall - 1987*
4. *Majumdar - 'Oil Hydraulics and Pneumatics' - Tata McGraw Hill Publishing Company Limited - 2005*

15MEC251 FUNDAMENTALS OF NUCLEAR ENGINEERING 3 0 0 3

Unit 1

Principles of nuclear energy: Introduction - Atomic structure - Energy from Nuclear reactions - Nuclear Fission and Fusion – radioactivity - Decay rates and Half Lives - Neutron Flux - Reaction rates.

Neutron diffusion theory: Diffusion equation - Solution of Diffusion Equation – Thermal Diffusion Length – Diffusion In Multiplying Systems - Slowing Down of Neutrons - Neutron Transport Equation and its approximation.

Unit 2

Components of nuclear reactors: Nuclear Fuel rod – Coolant-control rod – Moderator - Cladding – Reflectors - Shielding Materials - reprocessing of spent Fuels - Nuclear Waste treatment systems.

Power reactor systems: Pressurised water reactors - Boiling water reactors - Gas cooled and High temperature Gas cooled reactors - Pressurised Heavy water reactors - Fast breeder reactors - LMFBR & GCFBR.

Unit 3

Fuel management and reactor safety: fuel burnup - Core Management - control Management - Conversion ratio - Breeding ratio - Doubling Time - Biological effects of radiation – Radiation Hazards - Nuclear reactor Safety.

TEXTBOOKS:

1. *El Wakil M.M. - 'Power Plant Technology' – McGraw Hill - 2010 - 5th Edition*
2. *Glarstone S. - 'Principles of Nuclear reactor Engineering' - D Van Nostrand - 1982*

REFERENCE:

Stephenson R. - 'Introduction to Nuclear Engineering' – McGraw Hill - 1982

15MEC252 GAS DYNAMICS AND JET PROPULSION 3 0 0 3

Unit 1

Basic concepts: Energy and momentum equations of compressible fluid flows - Stagnation states - Mach waves and Mach cone - Effect of Mach number on compressibility. Isentropic flows: Isentropic flow through variable area ducts.

Isentropic Flow: Nozzle and Diffusers, compressors and turbines - Use of Gas tables. Flow through ducts: Flow through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) - Variation of flow properties - Use of tables and charts - Generalized gas dynamics.

Unit 2

Normal and oblique shocks: Governing equations - Variation of flow parameters across the normal and oblique shocks - Prandtl Meyer relations – Expansion of supersonic flow, Use of table and charts - Applications.

Unit 3

Jet propulsion: Theory of jet propulsion - Thrust equation - Thrust power and propulsive efficiency - Operation principle - cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan and turbo-prop engines – Aircraft combustors.

Space propulsion: Types of rocket engines - Propellants - Ignition and combustion - Theory of rocket propulsion – Performance study - Staging - Terminal and characteristic velocity - Applications - Space flights.

TEXTBOOKS:

1. *John D. Anderson Jr. - 'Modern Compressible Flow with historical perspective' - McGraw Hill Publishing company - International Edition - 1990 - 2nd Edition*
2. *Yahya S. M. - 'Compressible Flow' - Tata McGraw Hill India - 2009*

REFERENCES:

1. *Balachandran P. - 'Fundamentals of Compressible Fluid Dynamics' - PHI Learning India Private Ltd. - 2009*
2. *Cohen H., Rogers G. E. and Saravanamuttoo - 'Gas Turbine Theory' – Longman - 1980*
3. *Sutton G. P. - 'Rocket Propulsion Elements' - John Wiley, New York - 1986.*

4. *Shapiro A. H. - 'Dynamics and Thermodynamics of Compressible Fluid Flow - Vol.I' - John Wiley, New York - 1953*
5. *Radhakrishnan E. - 'Gas Dynamics' – Prentice-Hall of India Pvt. Ltd - 2004*

15MEC253 INTERNAL COMBUSTION ENGINES AND POLLUTION CONTROL 3 0 0 3

Unit 1

Spark Ignition engines: Mixture requirement - Feedback control carburettors - Fuel injection systems. Stochiometric combustion - combustion with excess air-equivalence ratio.

Stages of combustion: Normal and Abnormal combustion – Knock Combustion chambers. Simple thermodynamic analysis of SI engine combustion.

Unit 2

Compression ignition engines: Nature of combustion in IC engines - Direct and Indirect injection systems - Air motion - Combustion Chambers - Spray penetration and evaporation. Supercharging - Turbo charging. Thermodynamic analysis of CI engine combustion. Wankel Engine: Operation & applications. Hybrid vehicles.

Thermo chemistry: Pollutant formation, Instrumentation to measure pollutants - Pollutant calculation - Effect of air-fuel ratio.

Unit 3

Emission standards: EGR on engine emissions - Emission standards - Emission control devices. Thermal & catalytic exhaust clean–up catalysts - automotive catalytic converters - Engine modifications to reduce emissions. Heat release analysis of IC engines.

Alternate Fuels: Engine modifications for alternate fuels (liquid and gaseous fuels), homogenous charge compression ignition engines.

TEXTBOOKS:

1. *Heywood J. B. - 'Internal Combustion Engine Fundamentals' - McGraw-Hill - 1998*
2. *Obert E. F. - 'Internal Combustion Engines and Air pollution' - Harper and Row - 1973*

REFERENCES:

1. *Ferguson C. R. - 'Internal Combustion Engines' - John Wiley - 1989*
2. *Ganesan V. - 'Internal Combustion Engines' - Tata McGraw Hill Publishing Company Limited, New Delhi - 1998*
3. *Degobert P. - 'Automobiles and Air Pollution' - SAE - 2002*
4. *Campbell A. S. - 'Thermodynamic Analysis of Combustion Engines' - John Wiley - 1979*

15MEC254 PETROLEUM REFINERY ENGINEERING 3 0 0 3

Unit 1

Origin, Extraction and Testing of petroleum.

Petroleum - Origin, nature, composition, classification, exploration, drilling, transportation and storage. Petroleum processing - Nature of crude from India, Indonesia, Burma and Middle East countries, classification of crude, evaluation of petroleum - Important properties and test methods T.B.P. and ASTM distillation.

Refining of Petroleum - Dewatering and desalting - Primary Oil refining - Treatments of crude - Topping, vacuum distillation.

Unit 2

Thermal cracking, visbreaking and coking, catalytic cracking, fluid bed and hydro cracking, reforming, chemical reforming and catalytic reforming, polymerization, alkylation, hydrogenation isomerisation, cyclization.

Treatment processes: Sweatening, desalting, hydrogen treatment, hydrodesulfurisation process, solvent extraction of kerosene, stabilization of gasoline. Lube oil manufacture - solvent dewaxing, solvent extraction, propane deasphalting, and treatment, clay treatment, hydro finishing, hydrotreatment, lube oil, additives and asphalt boiling.

Unit 3

Petroleum products: LPG Motor spirit, aviation gasoline, kerosene, aviation turbine fuel, white spirit, and solvents, diesel fuel, gas oil, fuel oil, petroleum coke, petroleum waxes, lubricating oil and bitumen. Petrochemicals - Olefines, acetylene, propylene, butadiene, isoprene, aromatics, benzene, xylene etc. Methanol, formaldehyde, chloromethane, ethylene oxide, ethanol amine, acetone, cumene, phenol, styrene, phthalicanhyride.

TEXTBOOKS:

1. *B. K. BhaskaraRao -'Modern Petroleum Refining Process' - Oxford IBH Publishing Company, New Delhi.*
2. *G. N. Sarkar - 'Advanced Petroleum Refining' - Khanna Publishers, Delhi - 2004*
3. *W. L. Nelson - 'Petroleum Refinery Engineering' - McGraw Hill*
4. *R. A. Meyer's, -'Hand Book of Petroleum Refining Process' - McGraw Hill*

REFERENCE:

N. K. Sinha - 'Petroleum Refining & Petrochemicals'

15MEC255 POWER PLANT ENGINEERING 3 0 0 3

Unit 1

Hydrological data - capacity and type -selection - General layout and types of hydro electric Power Plants.

General layout of diesel power plant and their components - Types of plant layouts - comparison of diesel plant with thermal plant.

Comparison and types of gas turbine power plants and their components, combined gas and steam power plants - Advantages of gas turbine plant over diesel and thermal plants.

Unit 2

General components of Nuclear reactors - types of reactors - location safety and economics of nuclear plants - comparison with thermal power plants.

Steam power plant layout and components - Modern steam generators - types - functions of super heater - Preheater - economizer and air heater.

Unit 3

Fuels and combustion - Fuel preparation and burning, grates, burners draft, combustion calculations, Boiler Trial, Fuel handling systems, Ash handling methods, Gas cleaning methods and dust collection.

Types of condensers - cooling towers - Water treatment methods

Economics of power plant operation - Instrumentation and control - variable load operation and economics.

TEXTBOOKS:

1. *El Wakil M. M. - 'Power Plant Technology' – McGraw Hill - 2010 - 5th Edition*
2. *Nagpal G. R. - 'Power Plant Engineering' - Khanna Publishers - 1998*

REFERENCES:

1. *Morse F. T. – 'Power Plant Engineering' - D. Van Nostrand Company Inc, - 1989*
2. *Joel Weisman and Roy Eckart – 'Modern Power Plant Engineering' - Prentice Hall - 2002*

15MEC256 REFRIGERATION AND AIR CONDITIONING 3 0 0 3

Unit 1

Refrigeration cycles: Vapour Compression Cycle - Simple saturated vapour compression cycle. Thermodynamic analysis of cycles. Refrigerant Classification – Designation - Alternate Refrigerants. Global Warming Potential & Ozone Depleting Potential aspects, vapour absorption systems.

System components: Refrigerant Compressors – Reciprocating, Open type & Hermetic type, Screw Compressors and Scroll Compressors - Construction and Operation characteristics. Evaporators - DX coil, Flooded type Chillers.

Unit 2

Expansion devices - Automatic Expansion Valves, Capillary Tuber & Thermostatic Expansion Valves. Condensing Units and Cooling Towers. Cycling controls and system balancing: Pressure and Temperature controls. Range and Differential settings.

Selection and balancing of system components - Graphical method.

Psychrometry: Moist air behaviour - Psychrometric chart - Different Psychrometric process analysis.

Unit 3

Air conditioning: Summer and Winter Air conditioning - Cooling Load Calculations - Air Distribution Patterns - Dynamic and Frictional Losses in Air Ducts - Equal Friction Method - Fan Characteristics in Duct Systems.

TEXTBOOK:

Stocker W. F. and Jones J. W. - 'Refrigeration & Air Conditioning' - McGraw Hill - 1985

REFERENCES:

1. *Dossat R. J. - 'Principles of Refrigeration' - John Wiley - 1989*
2. *Goshnay W. B. - 'Principles and Refrigeration' - Cambridge University Press - 1982*
3. *Prasad M. - 'Refrigeration and Air Conditioning' - Wiley Eastern -1995*

15MEC257 RENEWABLE SOURCES OF ENERGY 3 0 0 3

Unit 1

Solar energy: Solar Radiation - Empirical Equations - Solar Chart - Measurements of Solar Radiation and Sunshine. Solar Thermal Collectors - Flat Plate and Concentrating Collectors. Solar Thermal Power Plant. PV Systems and applications. Applications: Solar Desalination, Solar Pond, solar driers, Industrial Process Heat, etc.

Wind energy: Principles of wind power, site characteristics, Wind rows diagram, types of wind turbines – construction, working and performance characteristics, synchronization of wind energy with the grid.

Unit 2

Bio-energy: Methanation: Methanogenic bacteria, process of methanation, variables affecting the process, popular designs of bio gas plant – construction and working. Feed stock preparation. Application: Biomethanation of agro waste, animal waste and process industry waste – sugar industry, sago industry, etc,

Thermal: Pyrolysis, gasification process, variables affecting the process, types of gasifiers, construction and working of gasifiers. Application: Gasification of biomass, process industry waste viz. - paper mill, waste cotton mill, saw mill, etc,

Unit 3

Ocean energy: Tidal: Types of energy harnessing techniques, turbines – construction, working and performance characteristics. Ocean thermal: Open cycle, closed cycle, Components of ocean thermal power plant, working and challenges.

Fuel cells: Principle of working of Hydrogen, Carbon Monoxide, fuel cell etc.

TEXTBOOK:

1. *El Wakil M. M. - 'Power Plant Technology' – McGraw Hill - 2010 - 5th Edition*
2. *Rai G. D. - 'Non-Conventional Energy Sources' - Khanna, New Delhi - 1999*

REFERENCES:

1. *Garg H. P. and Prakash J. - 'Solar Energy, Fundamentals and Applications' - Tata McGraw Hill Publishing Company Limited, New Delhi -1997*
2. *Golding E. W. - 'The Generation of Electricity by Wind Power' - John Wiley, NJ, USA - 1976*

15MEC258 TURBOMACHINERY 3 0 0 3

Unit 1

Definition and Classification of turbomachines - Specific Work - T-s and h-s Diagram - Incompressible and compressible flow – Losses - Total–to–Total efficiency - Total-to-Static efficiency - Effect of reheat and preheat factor. Degree of reaction. Energy transfer - Euler's equation, velocity triangles.

Dimensional analysis, Dimensionless parameters and their physical significance, specific speed, Hydraulic Pumps: Centrifugal Pumps – Some definitions - Pump output and Efficiencies - Effect of Vane angle – Cavitation - Pump Characteristics - Multistage pumps.

Unit 2

Hydraulic Turbines: Classification of hydraulic turbines - Velocity triangles. Efficiencies of draft tubes - Hydraulic turbine characteristics. Francis and Kaplan turbines - Velocity triangles - Efficiencies of Draft tubes - Turbine characteristics.

Elementary cascade theory, cascade nomenclature, compressor cascade, turbine cascade, cascade efficiency. Dimensional analysis of compressible flow machines, stalling and surging.

Unit 3

Centrifugal Compressors: Constructional details - Stage Pressure rise - Stage

Pressure Coefficient - Stage Efficiency - Degree of Reaction - Various Slip factors - Introduction to Fans and Blowers, Working principle, Fan laws, Performance Characteristics.

Axial flow Compressors: general expression for degree of reaction; velocity triangles for different values of degree of reaction, Blade loading and flow coefficient, Static pressure rise, Workdone factor.

Steam and Gas Turbines: Axial turbine stages - Stage velocity triangles – Work - Single stage impulse turbine - Speed ratio - Maximum utilization Factor - Compounding of Turbines and its types, Degree of Reaction - Reaction Stages. Inward Flow radial turbine stages (IFR) - Working principle and Performance Characteristics.

TEXTBOOKS:

1. *Dixon S. L. - 'Fluid Mechanics & Thermodynamics of Turbomachinery' - Elsevier - 2012 - 6th Edition*
2. *Sayers A. T. – 'Hydraulic and Compressible flow Turbomachines' – McGraw Hill -1992*
3. *Yahya S. M. - 'Turbines, Fans and Compressors' - Tata McGraw Hill Publishing Company Limited - 2002*

REFERENCES:

1. *Douglas J. F., Gasiorek J. M. and Swaffield J. A. - 'Fluid Mechanics', - Addison-Wesley - 1999*
2. *Kadambi V. and Manohar Prasad - 'Energy Conversion - Vol.III: TurboMachinery' - New Age International Publishers - 1999*
3. *Church A. H. and Lal J. - 'Centrifugal Pumps and Blowers' - Metropolitan - 1995*

15MEC261 ADVANCED CASTING TECHNOLOGY 3 0 0 3

Unit 1

Melt processing techniques for ferrous and non-ferrous alloys such as stainless steels, nickel, titanium alloys. Vacuum melting equipment and practice.

Elementary aspects of pattern and mould design using CAD softwares. Resin-bonded mould and core making processes and machines. Special casting processes and their applications - low pressure die casting, investment casting, squeeze casting, thixo-forming. Illustrations of automotive and aerospace applications.

Unit 2

Gating and riser design - principles of fluid flow, governing equations, heat transfer applied to casting solidification, governing equations, boundary conditions for different casting methods, concept of directional solidification, gating and risers, application of simulation methods. Use of casting software in solving practical problems.

Unit 3

Casting defects and remedies. Inspection methods - visual, penetrant, magnetic, metallurgical, X - ray and Gamma ray radiography and Mechanization and Automation.

TEXTBOOK:

Jain P. L. - 'Principles of Foundry Technology' - Tata McGraw Hill, New Delhi - 2011 - 3rd Edition

REFERENCE BOOKS:

1. *Heine R. W., Loper C. R., and Rosenthal P. C. - 'Principles of Metal Castings' - Tata McGraw Hill, New Delhi - 1997 - 2nd Edition*
2. *Beeley- P. R. - 'Foundry Technology' - Butterworth Scientific, London - 2001*

15MEC262 ADVANCED MANUFACTURING PROCESSES 3 0 0 3

Unit 1

Non-traditional manufacturing processes - chemical machining – electro chemical machining - ultrasonic machining - physical setup, metal removal rate, process parameters, process capabilities, and applications.

Non-traditional manufacturing processes - electrical discharge machining - wire EDM - abrasive flow machining - physical setup, metal removal rate, process parameters, process capabilities, and applications

Unit 2

High-speed machining: high performance machining of components. Application of HSM, improved material removal rate, surface finish and integrity, accuracy, economic considerations.

Unit 3

Modern grinding technologies, high speed and high performance grinding. Hard machining using single point tools.

Laser applications in manufacture: Cutting, welding, surface treatment, automation and in-process sensing.

TEXTBOOK:

Serope Kalpakjian and Steven R. Schmid - 'Manufacturing Engineering and Technology' - Prentice Hall – 2013 - 7th Edition

REFERENCE BOOKS:

1. *Benedict G. F. - 'Non-Traditional Manufacturing Processes' - Marcell Dekker Inc., NY - 1987*
2. *Krar S. F. and Gill A. - 'Exploring Advanced Manufacturing Technologies' -Industrial Press - 2003*

15MEC263 ADVANCED MATERIALS AND PROCESSES 3 0 0 3

Unit 1

Composite Materials: Types of metal matrices and reinforcements and their properties, bonding mechanisms, structure-property relationships, preforms, design of composites. Physical and Mechanical properties. Characterization of microstructures and macrostructures. Fabrication techniques - metal infiltration, pressure and vacuum casting methods. Case studies.

Unit 2

Aerospace Alloys: High strength Aluminium and Magnesium alloys, Nickel and Cobalt based Superalloys, Titanium alloys, their structures, structure-property relationships, heat treatment. Directional solidification and single crystal turbine blades. Case studies.

Unit 3

Smart Materials: Concept of shape memory, crystal structure, phase transformation mechanism and characteristics, properties, classification, applications.

Nanomaterials: properties, classification, characterization, materials behaviour, fabrication and applications.

TEXTBOOKS:

1. *Clyne T. W. and Withers P. J. - 'An Introduction to Metal Matrix Composites' - Cambridge University Press - 2003*
2. *Duerig T. W, Melton K. N., Stöckel D. and Wayman C. M. - 'Engineering Aspects of Shape Memory Alloys' - Butterworth Heinemann - 1990*

REFERENCES:

1. *'Handbook of Nanostructured Materials and Nanotechnology' - Academic Press - 2000*
2. *Wang Z. I., Liu Y. and Zhang Z. - 'Handbook of Nanophase and Nanostructured Materials: Vol 1. Synthesis' - Kluwer Academic/Plenum Publishers - 2002*
3. *Sinha A. K. - 'Physical Metallurgy Handbook' - McGraw Hill - 2002*

15MEC264 ADVANCED METROLOGY AND SENSING SYSTEMS 3 0 0 3

Unit 1

Computer Aided Inspection: High precision measurements – interfacing - software metrology - Automated visual inspection in manufacturing, contact and non - contact type inspection methods, Electrical field techniques, radiation techniques, ultrasonic - Atomic Force Microscopes (AFM), Talysurf instruments. Laser Metrology: Laser Interferometer, Alignment Telescope, laser scanners. On-line and in - process

measurements - diameter, surface roughness, Micro holes, surface topography measurements, straightness and flatness measurement, speckle measurements.

Unit 2

Coordinate Measuring Machine: CMM Types, Applications - Non-contact CMM using Electro optical sensors for dimensional metrology - Non-contact sensors for surface finish measurements – Measurements / programming with CNC CMM – Performance evaluations – Measurement integration. Machine Vision: Image Acquisition and Processing - Binary and gray level images, image segmentation and labelling, representation and interpretation of colours.

Unit 3

Edge detection techniques, Normalization, Grey scale correlation – Reflectance map concepts; surface roughness and texture characterization - photogrammetry. Application of Machine Vision in inspection - Measurement of length, diameters, Surface roughness - automated visual inspection - 3D and dynamic feature extraction. On-line Quality control: On-line feedback quality control variable characteristics - control with measurement interval, one unit, and multiple units control systems for lot and batch production.

TEXTBOOKS / RFERENCES:

1. *Marshall A. D. and Martin R. R. - 'Computer Vision, Models and Inspection' - World Scientific - 1998*
2. *Nello Zuech - 'Understanding and Applying Machine Vision' - Marcel Dekker - 2000 - 2nd Edition*
3. *John A. Bosch, Giddings, and Lewis Dayton - 'Coordinate Measuring Machines and Systems' - Marcel Dekker - 1999*
4. *ASTE - 'Handbook on Industrial Metrology' - Prentice Hall - 1992*

15MEC265 ADVANCED WELDING TECHNOLOGY 3 0 0 3

Unit 1

Overview of welding processes and their classification, types of joints, edge preparation, weld symbols, weld nomenclature, bead geometry, power density, heat sources - Gaussian distribution of heat flux, welding techniques - linear and orbital. Arc characteristics. Voltage-current characteristics. Types of welding manipulators and their applications.

Advanced welding processes: submerged arc, TIG, MIG, electro-slag, ultrasonic, electron beam and laser beam welding. Case studies and applications - industrial, automotive and aerospace.

Unit 2

Thermal modeling and simulation of welding processes - governing heat transfer equations and boundary conditions for various types of welding processes. Estimation of cooling rates. Prediction of mechanical properties, micro/macro-structures of weldments and heat-affected zone. Prediction of weld defects such a crack, segregation, lack of fusion. Modeling and simulation of pulsed arc processes. Use of softwares for simulation.

Solidification behaviour of fusion weld: structural zones, epitaxial growth, weld pool shape and columnar grain structures. Weldability of metals - steels, stainless steels, aluminium, copper, nickel and titanium alloys.

Unit 3

Microstructures of weldment. Segregation of alloying elements. Impact of micro/ macro-structures and segregation on mechanical properties. Pre - and post-treatment. Effects of heat flow on residual stresses and distortion. Weldability tests.

Welding defects - causes and remedies. Methods of testing weldments - mechanical, pressure and leak testing. Inspection methods - visual, penetrant, magnetic, ultrasonic, x-ray and gamma radiography. Use of imaging techniques for online monitoring.

TEXTBOOKS:

1. *Khanna O. P. - 'A Text Book on Welding Technology' – Dhanpat Rai and Sons, New Delhi - 2013*
2. *Parmar R. S. - 'Welding Process and Technology' - Khanna Publishers, Delhi - 1992*

REFERENCES:

1. *Little R. L. - 'Welding and Welding Technology' - Tata McGraw Hill Publishing Company Limited, New Delhi - 1989*
2. *Grong O. - 'Metallurgical Modelling of Welding' - The Institute of Materials - 1997 - 2nd Edition*
3. *Kou S. - 'Welding Metallurgy' - John Wiley Publications, New York - 2003 - 2nd Edition.*

15MEC266 CNC MACHINES 3 0 0 3

Unit 1

Introduction: Definition of automation, types of automation, Definition of NC, basic components of NC system, the NC procedure, NC Coordinate system, NC motion control systems, Interpolators – linear, circular and parabolic, applications of numerical control.

Features of CNC Machine Tools

Structure, Spindle design, spindle bearings, spindle drives, feed drives – DC servo motors, stepper motors and AC servo motors, actuation systems – recirculating ball screws and anti-friction guide ways, feed-back devices – optical rotary encoders and linear scales.

CNC Machining center developments, turning center developments, high speed CNC machine tools, automatic tool changers.

Manual Programming

Turning center programming: Axes system, ISO standards for coding, tool function, speed function, feed function, miscellaneous functions, rapid positioning, linear interpolation, circular interpolation, thread cutting, canned cycles

Unit 2

Machining center programming: axes system, tool function, speed function, feed function, miscellaneous functions, rapid positioning, linear interpolation, circular interpolation, tool length compensation, canned cycles for drilling, tapping and boring, cutter radius compensation.

Computer Aided Part Programming

APT language structure, Geometry statements, Motion statements, Post processor & auxiliary statements, MACROs, complete part programming in APT.

Unit 3

CNC Tooling

Turning tool geometry, modular tooling systems for turning, collet chucks, end mill adapters, morse taper adapters, boring heads and tapping heads, milling tooling systems, tool presetting, work holding devices - vices, grid plates, pneumatic and hydraulic clamps.

Assembly Techniques

Guide ways, ball screws and nut, feedback elements, spindle bearings.

Testing of CNC Machine Tools

Introduction, verification of technical specifications, functional aspects, verification during idle running, verification of machine tool accuracy and work piece accuracy, metal removal capability test, safety aspects.

TEXTBOOKS:

1. *Yoram Koren - 'Computer Control of Manufacturing Systems' - McGraw Hill Publishers - 2007*
2. *HMT Ltd. - 'Mechatronics' - Tata McGraw Hill Publishers - 2001*

REFERENCES:

1. *P. N. Rao - 'CAD/CAM, Principles and Applications' - Tata McGraw Hill Publishers - 2004*
2. *Mikell P. Groover and Emory W. Zimmers - 'CAD/CAM' - PHI Publishers - 2002*

15MEC267 COMPOSITE MATERIALS AND PROCESSING 3 0 0 3

Unit 1

Types of reinforcements, their mechanical properties and functions - ceramics, glass, carbon, boron, silicon carbide, metal, aramid. Forms of reinforcements - particulate, fibre, filaments, whiskers, flakes. Pre-fabricated forms - preforms, prepegs, fabrics, honeycomb.

Type of matrix, its mechanical properties and functions - polymers (thermosets and thermoplastics), metals, ceramics, glass and carbon. Basic principles in the design of composites and selection of matrix and reinforcement. Bonding mechanisms.

Unit 2

Anisotropic Behaviour and relationship between structure-mechanical properties.

Mechanical testing - tensile, compressive, Intra-laminar shear, Inter-laminar shear and fracture.

Polymer Matrix Composites: Types of thermoset and thermoplastic resins. Principles in the selection of matrix and the reinforcements. Process selection criteria. Mould and tool making. Basic manufacturing steps - impregnation, lay-up, consolidation and solidification.

Unit 3

Manufacturing processes for polymer composites - lay-up, compression moulding, extrusion, injection moulding, sheet forming, pultrusion, hot press & autoclave techniques and filament winding. Applications - industrial, automotive and aerospace.

Metal and ceramic matrix composites - wettability of reinforcement to matrix and bonding, methods of manufacturing reinforcements with intermediate wetting layer. Manufacturing processes for metal matrix composites: casting methods - gravity & low pressure die, investment, squeeze, spray forming, compression moulding and thixo-moulding. Manufacturing processes for ceramic matrix composites: reaction sintering, electro-deposition, spray forming, infiltration. Applications - industrial, automotive and aerospace.

TEXTBOOKS:

1. *Clyne T. W. and Withers P. J. - 'An Introduction to Metal Matrix Composites' - Cambridge University Press - 1993*
2. *Matthews F. L. and Rawlings R. D. - 'Composite Materials: Engineering and Science' - Chapman & Hall, London - 1994*

REFERENCES:

1. *Suresh S., Martensen A., and Needleman A. - 'Fundamentals of Metal Matrix Composites' - Butterworth, Heinemann - 1993*
2. *Mallick P. K. - 'Fiber-reinforced Composites: Materials, Manufacturing and Design' - Marcel Dekker – 1993*
3. *Mazumdar S. K. - 'Composites Manufacturing - Materials, Product & Process Engineering' - CRC Press - 2002*

15MEC268 METAL FORMING TECHNOLOGY 3 0 0 3

Unit 1

Fundamentals of Metal Forming: Theory of Plasticity - stress tensor – Invariants of stress strain - hydrostatic & deviator components of stress – flow curve – true stress and true strain. Yielding criteria – yield locus – octahedral shear stress and shear strains. Plastic deformations of crystals - critical resolved shear stress. Metal working: mechanics of metal working – working temperature - strain rate effects – friction and lubrication – deformation zone geometry.

Unit 2

Forging and Rolling Processes: Forging process – classification – equipment – calculation of forging loads – forging defects – residual stresses. Rolling: classification - rolling mills - rolling of bars & shapes – rolling forces – analysis of rolling – defects in rolling - theories of hot & cold rolling – torque power estimation.

Extrusion and Drawing Processes: Extrusion: classification - equipment – Analysis of extrusion process - extrusion defects – hydrostatic extrusion – tube extrusion. Drawing: Classification - rod & wire drawing equipment – analysis. Deep drawing – tube drawing – analysis, residual stresses.

Unit 3

Sheet Metal Forming Processes: methods – shearing and blanking – bending – stretch forming – deep drawing – forming limit criteria – defects.
Special Forming Methods: Stretch forming – press brake forming – explosive forming – electro hydraulic forming – magnetic pulse forming – super plastic forming – electro forming – fine blanking - Isothermal forging – HERF.

TEXTBOOK:

Dieter G. E. - 'Mechanical Metallurgy' - TATA McGraw-Hill - 2013 - 3rd Edition

REFERENCES:

1. *Altan T., Oh S. I., and Gegei H. L. - 'Metal Forming Fundamentals and Applications' - ASM, USA - 1983*
2. *Hosford W. F. and Caddel R. M. - 'Metal forming - Mechanics & Metallurgy' - Prentice Hall Publishing Co. - 1990*
3. *SME - 'Tool and Manufacturing Engineers Hand Book - Vol2' - McGraw Hill NY -1984*

15MEC269 MICRO-MANUFACTURING 3 0 0 3

Unit 1

Micromachining – definition - principle of mechanical micromachining - Classification of micromachining and nanofinishing processes - Molecular dynamics simulations of machining at atomic scale.

Diamond Turn Machining (DTM) - components of DTM – requirements of DTM - material removal mechanism – molecular dynamics - tool geometry. Abrasive Jet Micromachining - erosion mechanism - powder feeding - microstructure fabrication. Ultrasonic micromachining – basic elements - mechanism of material removal - micro-hole drilling, contour machining, micro-de-burring, machining of ceramic materials. Electrochemical micromachining.

Unit 2

Micro-electric discharge micromachining – principle - Micro EDM system development - process parameters - Analytical Modeling. Laser micromachining techniques and their applications. Focused Ion Beam machining. Electro chemical spark micromachining – mechanism - equipment. Electron beam micromachining – mechanism-process parameters - applications.

Unit 3

Microfabrication - Materials for Microsystems manufacture - Substrates and Wafers, active substrate materials, silicon and silicon components. Photolithography based micro fabrication processes - Photo resist development. Additive and subtractive techniques – CVD – PVD – etching - chemical, plasma - resists removal. Large aspect ratio micro manufacturing - LIGA, Deep Reactive Ion Etching.

Micro Metrology - Scanning Electron Microscopy, optical microscopy, atomic force microscope, molecular measuring machine, Micro-CMM, Transmission electron microscope – principles - applications.

TEXTBOOKS:

1. *Madou M. J. - 'Fundamentals of Microfabrication' - CRC Press - 2009 - 2nd Edition*
2. *Jain V. K. - 'Introduction to Micromachining' - Narosa Publishing House - 2010*

REFERENCES:

1. *Ran Hsu, T. R. 'MEMS & Microsystems: Design and Manufacturing' - Tata McGraw- Hill - 2002*
2. *Mohamed Gad-el-Hak - 'The MEMS Handbook' - CRC Press - 2002*

15MEC270 MODERN PRACTICES IN PRODUCT DESIGN AND MANUFACTURE 3 0 0 3

Unit 1

Creativity & Innovation: Aesthetics – Industrial design concepts – capturing customer voice – New product development – QFD.

Computer Aided Design (CAD): The design process - product cycle - sequential and simultaneous engineering, Computer Aided Engineering, Geometric modeling, parametric design. Design for manufacturability and Assembly, Features of CAD packages – Assembly of parts – tolerance analysis – Mass property calculations - Data Exchange Formats – Selection of alterative materials for Engineering Design.

Unit 2

Computer Aided Manufacturing (CAM): CNC Technology - Functions of CNC Control in Machine Tools - Classification of CNC systems - Contouring System - Interpolators, open loop and closed loop CNC systems - CNC Controllers, Hardware features - Direct Numerical Control (DNC Systems) - Numerical control codes – Standards - Manual Programming - Canned cycles and subroutines - Computer assisted Programming – CAD/CAM approach to NC part programming. APT language - Machining from 3D models - Virtual Manufacturing, NC verification.

Unit 3

Reverse Engineering & Rapid Prototyping (RP): Conventional vs Reverse Engineering process, Basic phases, cloud point generation - Related Hardware and software. Rapid product development - RP Data formats and information workflow, characteristics of generative manufacturing processes, Industrial Rapid prototyping system - Technical characteristics and Technological capabilities of RP systems. Concept Modelers. RP process optimization. Direct and Indirect tooling. Application of RP and RT in industrial product development - Medical Models - Engineering analysis models - Art and Architecture models, scope for research.

Recent Advances in Product Development methods and strategies: Concurrent Engineering - Total approach to product development – Collaborative design - Product Data Management – PLM – CPC – Understanding of various software application packages available in the market for various phases of the product life cycle – Design for Environment – Product Costing - Design for Six sigma - Design FMEA.

TEXTBOOKS:

1. *Zeid I. - 'CAD-CAM Theory and Practices' - Tata McGraw Hill - 2012*
2. *Groover M. and Zimmers - 'CAD-CAM, Computer Aided Design and Manufacturing' - Prentice Hall of India, New Delhi, - 2013*

REFERENCES:

1. *Gebhardt A. - 'Rapid Prototyping' - Hanser Publishers, Munich - 2003*
2. *Lii L., Fuh J. Y. H. and Wong Y. S. - 'Laser Induced materials and processes for Rapid Prototyping' - Kluwer Academic Publishers - 2001*

15MEC271 NON-DESTRUCTIVE TESTING 3 0 0 3

Unit 1

Introduction: Non-Destructive testing - Relative Merits and Limitations - NDT vs Mechanical testing. Dry technique and Wet technique – Principle – Applications - Advantages and Limitations. Dyes - Developers – Cleaners. Fluorescent penetrant test. Liquid penetrant inspection.

Radiography: X-rays and Gamma rays, Properties of X-rays relevant to NDE - Absorption of rays - scattering. Types and use of Filters – screens - Geometric factors, Film type and Processing. Characteristics of films graininess, Density, Speed, Contrast. Characteristic curves. Characteristics of Gamma rays - fluoroscopy – X-ray – Radiography. Safety with X-rays and Gamma rays.

Unit 2

Ultrasonic Testing: Types of Ultrasonic Waves - Principles of wave propagation - Characteristics of ultrasonic waves - Attenuation. Production of ultrasonic waves - Couplants. Inspection methods - pulse echo, Transmission and Resonance techniques. Thickness measurement. Types of scanning. Test block - Reference blocks.

Unit 3

Techniques for Specific Purposes: Magnetic particle inspection - Principles – Applications - Magnetization methods - Magnetic particles, demagnetization. Eddy current testing - Thermal inspection Principle, Application - Instrumentation of Thermal Inspection. Holography. Acoustic Emission. Pressure and Leak Testing. Chemical Spot Testing. Spark Testing.

TEXTBOOKS:

1. *Cartz L. - 'Non-Destructive testing' - ASM International, Metals Park Ohio, US - 1995*
2. *Raj B., Jayakumar T., and Thavasimuthu M. - 'Practical Non-Destructive Testing' - Narosa, New Delhi - 1997*

REFERENCE:

ASM Metals Hand Book, 'Non-Destructive Evaluation and Quality Control' - American Society of Metals, Metals Park Ohio, USA - 1989

15MEC272 PRODUCT COST ESTIMATION 3 0 0 3

Unit 1

Cost estimation: Importance and aims of cost estimation - functions of estimation - difference between estimating and costing - importance of preparing realistic estimates - estimating procedure.

Elements of cost, Objectives - elements of costs - ladder of cost - determination of material cost - labour cost - expenses.

Unit 2

Analysis of overhead expenses, Distribution of overhead costs – depreciation - causes of depreciation - methods of calculating depreciation.

Estimation of machining time, Calculation of machining time for lathe operations-estimation of drilling time on drilling machine - estimation of time for shaping, planning, milling and grinding.

Unit 3

Costing for metal forming and fabrication processes, Estimation of cost in welding-estimation in forging shop - cost estimation of foundry work.

TEXTBOOKS:

1. *Banga T. R. and Sharma S. C. - 'Mechanical Estimating and Costing including Contracting" - Khanna Publishers - 2011*
2. *O. P. Khanna - 'Mechanical Estimating and Costing' – Dhanpat Rai Publishers - 1999*

REFERENCES:

1. *Narang G. B. S and Kumar V. - 'Production and Costing' - Khanna Publishers - 2004*
2. *Adithan M. and Pabla B. S. - 'Production Engineering Estimating and Costing' - Konark Publishers (P) Ltd. - 1998*

15MEC273 QUALITY CONTROL AND RELIABILITY ENGINEERING 3 0 0 3

Unit 1

Introduction: Review of statistics and probability. Quality related costs, contemporary quality engineering philosophy, Quality systems and international standards and 6 Sigma. Control charts for variables: X-bar and R charts, X-bar and S charts; Control charts for individual measurements; Exponentially Weighted Moving Average (EWMA) and Deviation (EWMD) charts.

Unit 2

Control charts for attributes: p, np, c, and u charts Interpretation of control charts.

Average Run Length (ARL) Study. Multivariate quality control. Control charts for short production runs, Modified acceptance control charts. Sensitivity analysis - Process capability analysis.

Introduction to Reliability: Concepts and definition of Reliability – Reliability mathematics – failure distributions.

Unit 3

Hazard models – hazard rate function – failure density function – conditional reliability – exponential, Rayleigh, Weibull, Normal and Lognormal distributions – two - parameter exponential and three-parameter Weibull distributions – MTTF, MTBF – design life.

Reliability of simple Systems – Series and parallel configurations – Reliability improvement – redundancy – combined series and parallel systems – High level and low level redundancy – k-out of n system – standby redundancy.

Maintainability – Factors affecting maintainability of systems – Design for maintainability - MTTR – Maintenance – spare provisioning.

TEXTBOOKS:

1. *Montgomery D. C. - 'Introduction to Statistical Quality Control' - John Wiley - 2010*
2. *Ebeling C. - 'An Introduction to Reliability and Maintainability Engineering' - Tata McGraw Hill Publishing Company Ltd. - 2004*

REFERENCES:

1. *Eugene G. L. - 'Statistical Quality Control' - McGraw-Hill - 1996*
2. *Srinath L. S. - 'Concept in Reliability with an Introduction to Maintainability and Availability' - Associated East-West - 1998*
3. *Lewis E. E. - 'Introduction to reliability Engineering' - John Wiley & Sons - 1987*
4. *Rao S. S. - 'Reliability Based Design' - McGraw Hill - 1992*
5. *Barlow R. E., Proselan R. E. and Hunter L. C. - 'Mathematical Theory of Reliability' - John Wiley, New York - 1965*
6. *Halpern S. - 'The Assurance Services, an Introduction to Reality control and Reliability' - Prentice Hall, New Jersey - 1977*
7. *O'cconer P. D. T. - 'Practical Reliability Engineering' - John Wiley & Sons Ltd. - 2003*

15MEC274 SIMULATION MODELING OF MANUFACTURING SYSTEMS 3 0 0 3

Unit 1

Introduction: Introduction to manufacturing systems – Introduction to simulation – applications – System and System Environment – Types of Simulation - Simulation procedure – Examples of simulation.

Introduction to Simulation softwares.

Probability distributions: Review of basic probability and statistics – Probability distributions – Random number generators – Testing of Random numbers.

Unit 2

Analysis of Simulation input data: Data Collection – Statistical analysis of numerical data – Tests for Independence and Identically distributed data - Distribution fitting – selecting a distribution in the absence of data – Modelling discrete probabilities – Demonstration of input modelling using Arena Simulation package.

Model Building of Discrete systems: Modelling Paradigms - Modelling of Structural elements and Operational elements – Modelling issues – Model Verification and Validation.

Unit 3

Applications of Simulation in Manufacturing – Manufacturing Modelling Techniques – Modelling Material Handling system – Model building exercises using Arena - Case study.

Simulation output analysis: Design of Simulation Experiments: Determination of warm up period, Run length, Number of replications - Statistical analysis of simulation output – Terminating and Non-Terminating Simulations – Comparing alternative system designs – Variance reduction Techniques – Simulation Optimization.

TEXTBOOKS:

1. *Law A. W. and Kelton D. W. - 'Simulation Modeling and Analysis' - McGraw Hill - 2010 - 5th Edition*
2. *Kelton D. W., Sadowski R. P. and Sasowski D. A. - 'Simulation with ARENA' - McGraw Hill - 2009*

REFERENCES:

1. *Banks J., Carson J. S., Nelson B. L. and Nicol D. M. - 'Discrete Event System Simulation' - Pearson Education - 2001 - 3rd Edition*
2. *Viswanathan N. and Narahari Y. - 'Performance Modeling of Automated Manufacturing Systems' - Prentice Hall - 1998*

15MEC281 MATERIALS TESTING AND METALLURGY LAB. 0 0 2 1

Mechanical testing of materials: Experiments to determine Young's modulus, yield strength, ultimate tensile strength of ductile and brittle materials. Shear and impact test on materials, determination of Brinell's, Rockwell and Vicker's hardness, micro hardness, fatigue and flexural strength of materials.

Study of Metallurgical Microscope, study of microstructure of engineering materials, Study of effect of Heat Treatment on properties of mild steel, Jominy end quench test, Nondestructive testing of materials.

15MEC285 FLUID MECHANICS AND MACHINES LAB. 0 0 2 1

Calibration of flow measuring devices: Notches, Orifice meter, Venture meter, Verification of Bernoulli's equation, Reynolds apparatus and Meta centric height of a floating body. Experiments to study frictional losses in pipes, losses in bends and elbows.

Performance test on different types of pumps, Impact of jet on vanes, Performance test on different types of turbines.

15MEC301 DESIGN OF MACHINE ELEMENTS I 3 0 0 3

Unit 1

Introduction:

Design definition, Classification, General considerations, Design Procedure, Basic requirements of machine elements, Design Codes and Standard, Fits and Tolerance, Surface finish, Preferred numbers, Engineering Materials – Review of Mechanical properties of Engineering Materials, Material selection.

Design for Strength:

Design for Static Loading: Simple Stresses - tensile Stress, Compressive Stress and Shear Stress, Compound Stresses - Torsional Stress and Bending Stress, Types of Loading, Simple and Compound Stresses, Working Stress, Factor of Safety, Factors Influencing selection of FOS, Eccentric Loading, Combined Loading, Theories of Failure,

Design for Dynamic Loading: Impact load, Impact energy, Impact stress, Resilience, Toughness.

Stress Concentration: Stress Concentration, Stress Concentration Factor, Determination of Stress Concentration factor, Methods of Reducing Stress Concentration,

Unit 2

Variable and Cyclic Loads: Fatigue Load, Stress Cycle, Fluctuating loading, Reversed Loading, Repeated Loading, Endurance Strength, Endurance Limit, S-N Curves, Modifying Factors: Size effect, Surface effect, Stress Concentration effects, Goodman and Soderberg relationship; Stresses due to Combined Loading.

DESIGN OF SHAFTS: Design for strength and Rigidity with Steady loading, ASME & BIS codes for Power Transmission shafts, Shafts subjected to Combined Twisting Moment and Bending Moment, Shafts under Fluctuating loads and Combined loads.

KEYS AND COUPLINGS: Keys and Splines, Design of keys, Design of Rigid and Flexible couplings.

Unit 3

MECHANICAL JOINTS:

Riveted Joints: Types, Rivet Materials, Failures of Riveted Joints, Boiler Joints - longitudinal and circumferential.

Welded Joints: Types, Strength of Butt and Fillet welds, Eccentrically loaded Welded Joints

POWER SCREWS: Types of Screw Threads used for Power Screws, Torque required to Raise and Lower the load, Efficiency and Self-locking, Design of Screw Jack. Design of screws for C-Clamp and machine vice.

TEXTBOOKS:

1. *Robert L. Norton, Machine Deign - 'An Integrated Approach' - Pearson Education - 2011 - 2nd Edition*
2. *Bhandari V. B. - 'Design of Machine Elements' - Tata McGraw-Hill Education - 2010 - 3rd Edition*
3. *'Design Data: Data Book of Engineers' by PSG College Kalaikathir Achchagam - Coimbatore, 2012.*

REFERENCES:

1. *Shigley J. E. and Mische C. R. - 'Mechanical Engineering Design' - McGraw Hill Education (India) Private Limited - 2011 - 9th Edition*
2. *U. C. Jindal - 'Machine Design' - Pearson Publications - 2010 - 1st Edition*

15MEC302 DYNAMICS OF MACHINES 3 0 0 3

Unit 1

Static and Dynamic Force Analysis

Static force analysis of mechanisms - D' Alembert's principle - Inertia force and Inertia torque - Dynamic force analysis - Dynamic Analysis in Reciprocating Engines - Gas Forces - Equivalent masses - Bearing loads - Crank shaft Torque.

Flywheels

Turning moment diagrams - Flywheels of engines and punch press.

Unit 2

Balancing of rotating masses and Reciprocating masses

Static and dynamic balancing - Balancing of rotating masses - Balancing a single cylinder Engine - Primary and secondary unbalanced forces - Balancing Multi-cylinder Engines - Firing order - Balancing machines.

Unit 3

Control Mechanisms

Governors

Types - Centrifugal governors - Gravity controlled and spring controlled centrifugal governors - Characteristics - Effect of friction - Controlling Force - Quality of governors - effect of friction.

Gyroscope

Gyroscopic couple - Gyroscopic stabilization - Gyroscopic effects in Automobiles, Airplanes and Ships

TEXTBOOKS:

1. *Rattan S. S. - 'Theory of Machines' - McGraw Hill India Pvt. Ltd. - 2014 - 4th Edition*
2. *Ghosh A. and Mallick A. K. - 'Theory of Mechanisms and Machines' - Affiliated East West Press Pvt. Ltd., New Delhi - 2008*

REFERENCES:

1. *Thomas Bevan – 'Theory of Machines' - CBS Publishers and Distributors - 2005 - 3rd Edition*
2. *Shigley J. E. and Uicker J. J. - 'Theory of Machines and Mechanisms' Oxford Publishers - 2014 - SI units Edition*
3. *Rao J. S. and Dukkipati R. V. - 'Mechanism and Machine Theory'- New Age Publishers, New Delhi - 2008*
4. *John Hannah and Stephens R. C. – 'Mechanics of Machines' – 1999 - Viva low-Priced Student Edition*
5. *Sadhu Singh - 'Theory of Machines' - Pearson Education - 2011 - 3rd Edition*

15MEC303 HEAT POWER ENGINEERING 3 0 0 3

Unit 1

Combined first law and second law of open systems, reversible steady flow work, available energy, irreversibility, exergy and second law efficiency.

Vapour power cycles: Simple Rankine Cycle, reheat cycle, regenerative cycles

Steam nozzles: Steam flow through nozzles. Nozzle efficiency. Supersaturated or metastable expansion of steam in a nozzle. General relationship between area, velocity and pressure in nozzle flow.

Steam turbines: Impulse and Reactions turbine, compounding principles.

Unit 2

Internal combustion engines: Stoichiometry, enthalpy of formation and enthalpy of combustion, adiabatic flame temperature, Otto and Diesel cycles. Spark ignition engines and compression ignition engines. Indicator diagrams. Combustion phenomenon in S.I & C.I. engines. Diesel knock. Octane and Cetane number, Supercharging, Testing and performance of IC engines.

Air compressors: Design of reciprocating compressors. Effect of clearance and volumetric efficiency. Adiabatic, isothermal and mechanical efficiencies. Multistage compressor. Optimum intermediate pressure.

Unit 3

Gas turbines: Gas turbine cycles. Methods to improve efficiency of gas turbines. Jet propulsion.

Refrigeration systems: Air refrigeration systems. Vapour compression system. Vapour absorption system. Refrigerants.

Air conditioning systems: Psychrometry, Air-conditioning equipment, components and control, cooling load calculations.

TEXTBOOKS:

1. *Cengel, Y. A. and Boles M. A. - 'Thermodynamics and Engineering Approach' - Tata McGraw Hill, 2014 - 8th Edition*
2. *Kurt C. Rolle - 'Thermodynamics and Heat Power' - Merril Publishing Company, A.I.T.B.S. Publishers and Distributors, Delhi - 2001*

REFERENCES:

1. *Sonntag R. E., Borgnakke C. and Van Wylen, G. - 'Fundamentals of Thermodynamics', John Wiley and Sons - 2004*
2. *Rajput R. K.. - 'Thermal Engineering' - Laxmi Publications (P) Ltd., New Delhi - 2013 - 9th Edition*
3. *Pandya and Shah - 'Heat Engines' - Charotar Book Distributors – 2005 - 10th Edition*

15MEC304 MANUFACTURING PROCESS II 3 0 0 3

Unit 1

Theory of metal cutting: Types of metal cutting processes, Mechanism of chip formation - Forces and temperature in metal cutting, Tool life - Machinability and surface finish: Cutting tool materials and cutting fluids. Tool wear.

Cylindrical Surface Machining: Basics of turning process, lathe and its accessories, operations, process parameters. Machining time calculations.

Drilling Machines: Types, operations, process parameters. Design considerations for drilling operations.Machining time calculations.

Unit 2

Flat and Profile Machining: Milling operations - Milling machines: types, operations, process parameters. Planing and shaping machines -types, operations. Gear machining processes.

Finishing Processes: Theory of grinding process - Fundamentals of abrasives – Grinding wheels- Grinding operations and machines. Super finishing processes.

Unit 3

CNC Machines: Overview, types, construction, tool and work holding devices, feedback devices, part programming - examples.

Non-Conventional machining processes: Abrasive Jet Machining, Electrical Discharge Machining, Electrochemical Machining, Ultrasonic Machining, Laser Beam Machining, Electron Beam machining. Introduction to Rapid Prototyping & Rapid Tooling, Green manufacturing.

TEXTBOOK:

Serope Kalpakjian and Steven R. Schmid - ''Manufacturing Engineering and Technology' - Prentice Hall - 2013 - 7th Edition

REFERENCES:

1. *Hajra Choudhury S. K., Hajra Choudhury A. K., Roy N. - 'Elements of Workshop Technology' Media Promotors & Publishers Pvt. Ltd. - 2010 - Vol.II: Machine Tools, 13e*
2. *Jain R. K. and Gupta S. C. - 'Production Technology' - Khanna Publishers - 2008*
3. *Ghosh A. and Mallik A. S. - 'Manufacturing Science' - Affiliated East West Press Private Limited - 2010*
4. *'H.M.T. Production Technology: Hand book` - Tata McGraw-Hill Publishing Company Limited - 1990*

15MEC305 THERMAL ENGINEERING AND FLUID MACHINERY 3 0 0 3

Unit 1

Vapour Power Systems: Pure substance, formation of steam, components of vapour power plant, ideal Rankine cycle, effect of boiler and condenser pressure, improving performance – super heat and reheat.

Gas Power Systems: Components of diesel power plant, Internal combustion engines - terminology, classification, air standard Otto cycle and Diesel cycle, indicated power, brake power, efficiencies, specific fuel consumption. Components

of gas turbine power plant, modelling of gasturbine power plant, air standard Brayton cycle, generative gas turbines.

Unit 2

Fluid Machinery: Classification of fluid flow, properties of fluid, pressure variation in a fluid at rest, measurement of pressure, continuity, momentum and energy equations, applications of Bernoulli equation, Components of hydro power plant, centrifugal pumps – working principle, performance characteristics. Hydraulic turbines – classification, principles and operations of Pelton wheel, Francis turbine and Kaplan turbine.

Unit 3

Heat Transfer: Modes of heat transfer – conduction, convection and radiation. One dimensional steady state heat conduction through plane wall and cylinder, concept of insulation, critical thickness of insulation, heat transfer from extended surfaces, heat transfer with heat generation.

TEXTBOOKS:

1. *Michael J. Moran, Howard N. Shapiro, Bruce R. Munson, David P. DeWitt, "Introduction to Thermal Systems Engineering", John Wiley & Sons, 2003*
2. *R. K. Bansal, "Fluid Mechanics and Hydraulic Machines", Laxmi Publications, 2015*

REFERENCE BOOKS:

1. *Yunus A.Cengel and Michael A. Boles, "Thermodynamics – An engineering approach", Tata McGraw Hill, 2008*
2. *Yunus A. Cengel and John M. Cimbala, "Fluid Mechanics – Fundamentals and applications", Tata McGraw Hill, 2005*
3. *Yunus A. Cengel, "Heat Transfer – A Practical approach", Tata McGraw Hill, 2005*
4. *Incropera F. P and DeWitt D. P., "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 1988*

15MEC311 DESIGN OF MACHINE ELEMENTS II 3 1 0 4

Unit 1

BEARINGS

Lubrication, Bearings - Introduction, Viscosity, Classification, Hydrodynamic & Hydrostatic Lubrication, Pressure distribution - eccentricity and minimum film thickness, Thick & Thin film lubrication, Bearing materials,

Journal bearings (Sliding contact bearing) - Bearing characteristic numbers, Petroff's equation, Sommerfeld number, Mckee's equation, Journal bearings design.

Rolling Contact Bearings - Types, Static & Dynamic load carrying capacity, Reliability, Selection of antifriction bearings for Static & Dynamic conditions, Selection of antifriction bearings for constant and varying loads.

FLEXIBLE TRANSMISSION SYSTEM
Introduction, Classification & Application of flexible power transmission systems, Simple and Compound power drives.

Belt Drives - Flat belt drives, types, belt configuration, velocity ratio, slip, condition for maximum power transmission, length of open and cross belt drives, centrifugal tension, initial tension, selection of belts, flat belt pulleys, fast and loose pulleys, Designation of V-belt, Advantages and Disadvantages of v-belt drives, Selection of V-belt,

Rope Drives - Types, Designation of wire rope, Length of wire rope, factor of safety, Stresses in hoisting wire ropes, Selection of wire ropes, Wire rope Sheaves and Drums.

Chain drives - Introduction,Terms used in chain drives, Classification, Conveyor chains, Power transmitting chains, Roller chains, Factor of Safety for chain drives, Selection of chain drives.

Unit 2
GEARS - Types, Applications and Gear Terminology,

Spur Gears - Law of gearing, conjugate action and interference in gears, Gear tooth profiles, involute profile, Influence of number of teeth and pressure angle, Gear tooth failure modes, beam strength of gear tooth - Lewis equation, Gear materials, Force analysis, Design for strength, Dynamic and wear load.

Helical gears – Applications, Virtual number of teeth on helical gears, Force analysis, Design of helical gears.
Bevel Gears - Nomenclature of straight and spiral bevel gears, Applications, Design of bevel gears.

Worm Gears - Nomenclature of worm gears, Applications, Design of worm gears.

GEAR BOX
Gear Boxes - types, Gear tooth loads and bearing reactions, Standard speed ratios - speed diagram, Design of multi stage, multi speed gear boxes,

Unit 3
FRICTION DRIVES
Clutches - Introduction, Principle of operation of friction clutches, Clutch materials, friction lining materials, Types of clutches, Single plate clutches, Multi-plate clutches, Axial clutches, Cone clutches, Centrifugal clutches,Selection of clutches.

Brakes - Introduction, Energy to be dissipated, Heating of brakes, Shoe or Block brakes (Single & Double), internal and external shoe brakes, self-locking brakes, Differential band brakes, Internal expanding brakes.

TEXTBOOKS:

1. *Robert L Norton - 'Machine Deign - An Integrated Approach' - Pearson Education - 2011 - 2nd Edition*
2. *Bhandari V. B. - 'Design of Machine Elements' - Tata McGraw Hill Education - 2010 - 3rd Edition*
3. *'Design Data: Data Book of Engineers' by PSG College Kalaikathir Achchagam, Coimbatore, 2012.*

REFERENCES:

1. *Shigley J. E. and Mische C. R. - 'Mechanical Engineering Design' - McGraw Hill Education (India) Private Limited - 2011 - 9th Edition*
2. *U. C. Jindal - 'Machine Design' - Pearson Publications, 2010 - 1st Edition*

NOTE: Design of some of the above components for practical applications can be emphasized for better understanding and Continuous Evaluation of the Course.

15MEC312 HEAT TRANSFER 3 1 0 4

Unit 1
Heat transfer - basic modes of heat transfer and fundamental laws. Conduction heat transfer: energy balance, integral and differential approaches, general heat conduction equations in Cartesian, cylindrical and spherical coordinates, initial and boundary conditions. One-dimensional steady state conduction, thermal resistance networks, heat generation, variable thermal conductivity, critical insulation thickness, extended surface heat transfer, multidimensional steady conduction. Unsteady state heat conduction: lumped heat capacity, infinite and semi-infinite solids, numerical methods in conduction problems.

Unit 2
Convective heat transfer: Newton's law of cooling, Prandtl number, hydrodynamic and thermal boundary layer, forced convection, Nusselt number, empirical relations in forced convection for flat plates, cylinders and spheres, Flow over tubes and bank of tubes Internal flow and heat transfer: fully developed laminar flow in pipes, turbulent forced convection, free convection, Natural convection: dimensionless numbers, combined natural and forced convection, Phase change heat transfer: Pool boiling, convective boiling, film and drop wise condensation, empirical relations for heat transfer with phase change.

Unit 3
Heat exchangers: Types, classifications, selection, standards, parallel, counter and mixed flow, multiple passes, LMTD, correction factors, effectiveness, NTU methods. Process design and construction of double pipe and shell and tube heat exchangers.

Radiation heat transfer: electromagnetic radiation spectrum, thermal radiation, absorptivity, reflectivity, transmissivity, emissivity, black body, gray body and white body, monochromatic and total emissive power, Planck's law, Stefan-Boltzmann law, Wein's Displacement law, Radiation exchange between surfaces, view factors, radiation shields, greenhouse effect.

TEXTBOOKS:

1. *Holman J. P. & Bhattacharyya S. -'Heat Transfer' - McGraw Hill Education (India) Private Limited - 2011 - 10e*
2. *Cengel Y. A. & Ghajar A. J. - 'Heat and Mass Transfer' - McGraw Hill Education (India) Private Limited - 2011 - 4th Edition*

REFERENCES:

1. *Frank P. Incropera, David P. Dewitt, Theodore L. Bergman, Adrienne S. Lavine - 'Principles of Heat and Mass Transfer' - Wiley - 2013 - 7e*
2. *Donald Q. Kern - 'Process Heat Transfer', McGraw Hill Education (India) Private Limited - 2001*
3. *Adrian Bejan - 'Heat Transfer' - Wiley India Pvt Ltd. - 2011*
4. *M. Necati Ozisik - 'Heat Transfer: A Basic Approach' – McGraw Hill Inc. US - 1994*
5. *Louis C. Burmeister 'Convective Heat Transfer' - John Wiley & Sons - 1983*

15MEC313 INTRODUCTION TO FINITE ELEMENT METHODS 3 0 2 4

Unit 1

Introduction: Equilibrium equations in elasticity subjected to body force, traction forces, stress strain relations for plane stress and plane strain, Boundary conditions, Initial conditions, Euler's Lagrange's equations of bar, beams, Principal of a minimum potential energy, principle of virtual work, Rayleigh-Ritz method, Galerkins method, Guass elimination method, Numerical integration.

Basic Procedure: General description of Finite Element Method, Engineering applications of finite element method, Discretization process; types of elements 1D, 2D and 3D elements, size of the elements, location of nodes, node numbering scheme, half Bandwidth, Stiffness matrix of bar element by direct method, Properties of stiffness matrix, Preprocessing, post processing.

Interpolation Models: Polynomial form of interpolation functions - linear, quadratic and cubic, Simplex, Complex, Multiplex elements, Selection of the order of the interpolation polynomial, Convergence requirements, 2D Pascal triangle, Linear interpolation polynomials in terms of global coordinates of bar, triangular (2D simplex) elements, Linear interpolation polynomials in terms of local coordinates of bar, triangular (2D simplex) elements, CST element.

Higher Order and Isoparametric Elements: Lagrangian interpolation, Higher order one dimensional elements - quadratic, Cubic element and their shape functions, properties

of shape functions, Truss element, Shape functions of 2D quadratic triangular element in natural coordinates, 2D quadrilateral element shape functions – linear, quadratic, Biquadric rectangular element (Noded quadrilateral element), Shape function of beam element. Hermite shape function of beam element, Numerical integration.

Unit 2

Solid Mechanics Applications: Direct method for bar element under axial loading, trusses, beam element with concentrated and distributed loads, matrices, Jacobian, Jacobian of 2D triangular element, quadrilateral, Consistent load vector.

Solution of bars, stepped bars, plane trusses, space truss, beams and frames by direct stiffness method. Solution for displacements, reactions and stresses by using elimination approach, penalty approach. Plane stress, plane strain and Axisymmetric problems. Dynamic Analysis.

Unit 3

Heat Transfer and Fluid Flow Problems: Steady state heat transfer, 1D and 2D heat conduction governing equation, boundary conditions, One dimensional element, Functional approach for heat conduction, Galerkin approach for heat conduction, heat flux boundary condition, 1D heat transfer in thin fins, heat transfer 1D and 2D problems with conduction and convection.

Fluid flow problems and Introduction to Finite Element Packages and its application to solid mechanics, fluid and heat transfer problems

TEXTBOOKS:

1. *S. S. Rao - 'The Finite Element Method in Engineering' Butterworth-Heinemann Ltd. - 2010 - 5th Edition*
2. *K. J. Bathe - 'Finite Element Procedures' - Prentice-Hall of India - 2014 - 2nd Edition*

REFERENCES:

1. *O. C. Zienkiewicz - 'The FEM its basics and fundamentals' - Elsevier - 2013 - 7th Edition*
2. *J. N. Reddy - 'Finite Element Method' – McGraw Hill International Edition - 2005 - 3rd Edition*
3. *K. H. Huebner, D. L. Dewhirst, D. E. Smith and T. G. Byron - 'The Finite Element Method for Engineers' - John Wiley & Sons Inc., New York - 2001 - 4th Edition*
4. *Chandrupatla T. R. - 'Finite Elements in Engineering' - Pearson Edition - 2011 - 4th Edition*

15MEC314 METROLOGY AND MEASUREMENTS 3 0 0 3

Unit 1

Concept of Metrology: Definition and concept of Metrology - need of Inspection - Generalized measurement system - Units and standards - measuring instruments; sensitivity, stability, range, accuracy and precision, static and dynamic response, repeatability - systematic and random errors - correction; calibration.

Linear Measurements: Vernier-caliper, Vernier depth gauge, Micrometer, Depth micrometer, Digital micrometer. Slip gauges: wringing of slip gauges and classification - Tool maker's microscope. Dial indicators - classification and working mechanism. Limit gauges; Comparators: Mechanical, pneumatic and electrical types, applications - Height Gauge, Bore Gauge and Feeler Gauge.

Angular Measurements: Uses of the Vernier Bevel protractor, Universal Bevel protractor and Optical Bevel protractor. Sine bars – Uses and limitations of sine bar - Taper measurements. Sources of errors in sine bars, Sine Centre and Sine tables – Auto collimator and its applications.

Unit 2

Surface Texture and Screw Thread Measurement: Elements of surface texture - Evaluation of surface finish - Peak to valley height - Talysurf, Tomlinson surface meter - Screw thread terminology - Measurement of various elements of thread; Measurement of thread angle by two wire and Three wire methods; Thread gauges and floating carriage micrometer.

Form Measurements: Measurement of Straightness, Flatness, Parallelism, squareness testing, Roundness testing - Radius Gauge, Wire Gauge, etc.

Signal Representation – Signal conditioners, filters, ADC, DAC

Unit 3

Wheatstone bridge, use of bridge circuits - Displacement measurement - Potentiometer - LVDT, Piezo electric type - Velocity measurement.
Nature of Vibration, accelerometers.

Strain measurement types, mechanical strain gauge, Electrical strain gauge, selection of strain gauge.

Temperature measurement: Bimetallic thermometer, Platinum resistance thermometers, Thermocouples and Pyrometers – Pressure fundamentals; Elastic transducers, thermal conductivity gauges, Vacuum pressure measurement, Flow measurement - Ultrasonic flow meter - turbine type meters - Hot wire anemometers.

TEXTBOOKS:

1. *J. F. W. Gayler, and C. R. Shotbolt - 'Metrology for Engineers' ELBS -1990*
2. *JONES' - 'Instrument Technology' Volume - 1, Mechanical Measurement' - Edited by B. E. Noltingk - ELBS - 4th Edition*

REFERENCES:

1. *I. C. Gupta - 'Text Book of Engineering Metrology' – Dhanpat Rai, Publishing Company - 2011 - 7th Edition*

2. *Alan S. Morris - 'The Principles of Measurements and Instrumentation' - Prentice-Hall of India - 2001*
3. *R. K. Jain - 'Engineering Metrology' Khanna Publishers, Delhi - 2009 - 5th Edition*
4. *Gupta S. C. - 'Engineering Metrology' - Dhanpatrai Publications - 2010*
5. *Dr. D. S. Kumar - 'Mechanical Measurements & Control' - Metropolitan Book Co. Private Ltd. - ISBN 81-200 0214-8*
6. *Bechwith-Marangoni-Lienhard - 'Mechanical Measurements' - Pearson Education Asia - 2011 - 6th Edition Reprint.*

15MEC331 ENGINEERING ECONOMIC ANALYSIS 3 0 0 3

Unit 1

Economics: Nature and scope of managerial economics. Economic theory and managerial economics.

Cost Concepts: Types of costs - Cost functions. Cost controls: reduction – Tools & Areas. Pricing policies - methods. Capital budgeting - cost of capital. Appraising project profitability.

Unit 2

The essentials of demand and supply: The law of demand. Market demand curve. Other determinants of market demand. The law of supply. Determinants of market supply. The market mechanism.Price elasticity of demand.

Profit and revenue maximization: Optimal input combination. Total revenue maximization.

Unit 3

Market structure: Perfect competition and monopoly. Characteristics of monopolistic competition. Oligopoly.

Operations Research techniques in managerial economics: Inventory models. Theory of games. Decision theory, Risk and Uncertainty, Measuring risk, Consumer behavior and risk aversion, Decision making under uncertainty with complete ignorance

TEXTBOOKS:

Webster T. J. - 'Managerial Economics- Theory and Practice' - Elsevier - 2004

REFERENCE BOOKS:

1. *Panneerselvam, R. - 'Engineering Economics'– PHI - 2001*
2. *Varshney R. L. and Maheshwari K. L. - 'Managerial Economics' - S .Chand & Sons - 1997 - 13th Edition.*
3. *Harrison B, Smith C. and Davis B. - 'Introductory Economics' – Macmillan - 1992*

15MEC332 ENTERPRISE MANAGEMENT 3 0 0 3

Unit 1

Engineering Economics: cost concepts - types of costs - cost functions. Cost controls: reduction – tools & applications. Pricing policies – methods – problems.

Process design and improvement – process capacity – process layout – process reengineering – job design. Work standards – work measurement – work sampling – problems.

Unit 2

Supply Chain Management – Basic Concepts, SC dynamics, push-pull boundary, integrated supply chain, logistics, customer relationship, supplier relationship – selection, rating and development, procurement, SC metrics and performance measurement - problems. Lean Manufacturing – concepts, wastes – tools viz., pull system, standardized work, takt time, kanban system, JIT, kaizen, SMED, 5S, value stream mapping, benefits of lean and implementation issues. Introduction to Six Sigma. Plant Location – globalization, factors affecting location decisions, facility location - Break-even method, rectilinear, factor-rating and centre of gravity – problems. Plant Layout – types, process layout, product layout, Systematic layout planning (SLP), Line Balancing problems. Capacity Planning – Aggregate Planning – importance, planning process, methods – problems.

Unit 3

Role of IT in business performance improvement – e-commerce – e-purchasing – Master Production Schedule, inventory lot sizing strategies, MRP basics – MRP explosion, Available to Promise (ATP) inventory – MRP calculations – MRP II – Scheduling – Gantt chart – Introduction to ERP – ERP software – ERP modules – ERP implementation.

TEXTBOOKS:

1. *L. J. Krajewski and L. P. Ritzman - 'Operations Management: Processes and Value Chain' - PHI Pvt. Limited - 2010*
2. *R. L. Varshney & K. L. Maheshwari, 'Managerial Economics' - S Chand & Sons - 1997 - 13th Edition*

REFERENCES:

1. *W. J. Hopp and M. L. Spearman - 'Factory Physics' – McGraw Hill - 2000 - 2nd Edition*
2. *E. S. Buffa and R. K. Sariss - 'Modern Production / Operations Management' - John Wiley - 1994 - 8th Edition*
3. *B. Harrison, C. Smith and B. Davis - 'Introductory Economics' – Macmillan - 1992*

15MEC333 FINANCIAL MANAGEMENT 3 0 0 3

Unit 1

Introduction: Financial Management an overview – Financial Decisions in a firm – Goal of FM – Function of the financial system.

Fundamental Valuation Concepts: Time value of money – Risk and Return.

Unit 2

Capital Budgeting: Techniques of capital budgeting investment criteria – NPV – Benefit Cost Ratio – IRR – Payback Period – ARR – Investment appraisal in Practice – Estimation of Project cost flows.

Unit 3

Working Capital Management: Current Assets – Financing Ruling – Profit Criterion. Cash and Liquidity Management. Working Capital Financing.

Financial Analysis and Planning: Analyzing Financial Performance – Break – even analysis and Leverages – Financial Planning and Budgeting.

Mergers and Takeovers - International trade.

TEXTBOOK:

Chandra P. - 'Financial Management: Theory and Practice' - TMH - 2001 - 5th Edition

REFERENCES:

1. *Denzi Watson & Antony Head - 'Corporate Finance- Principles and Practice' - Pearson Education Asia, - 2002 - 2nd Edition*
2. *Terry S. Maness - 'Introduction to Corporate Finance' - McGraw Hill Book Company - 1988*
3. *Eugene F. Brigham & Louis C.Gapenski, 'Financial Management: Theory and Practice' - 2010 12th Edition*

15MEC334 INDUSTRIAL ENGINEERING 3 0 0 3

Unit 1

Work System: Elements of work, maintenance of machines, interaction, effect of working conditions and environment, physical and mental fatigue.

Productivity: Productivity, factors affecting production, Measurement of productivity.

Work Study: Definition and scope of work study; Areas of application of work study in industry; Human aspects of work study.

Method Study: Information collection, recording techniques, and processing aids; critical examination; development, installation and maintenance of improved methods.

Unit 2

Motion Economy and Analysis: Principles of motion economy; Motion analysis; Micromotion and Memomotion study; Therbligs and SIMO charts; Normal work area and design of work places; Basic parameters and principles of work design.

Work Measurement: Work measurement techniques; Calculation of standard time, work sampling and predetermined Motion time systems.

Wages and Incentive Schemes: Introduction, wage payment of direct and indirect labour, wage payment plans and incentives, various incentive plans, incentives for indirect labour

Unit 3

Plant Layout: Concept of plant layout, types of layout; factors affecting plant layout, work station design, factors considered in designing a work station.

Material Handling: Introduction and functions of material handling equipment, selection of material handling equipment for different requirements, safety requirements

.

Ergonomics: Ergonomic Design of equipment and work place. Ergonomic Design Standards - Study of development of stress in human body and their consequences. Case Studies.

TEXTBOOKS:

1. *Barnes R. - 'Motion and Time Study' - Design and Measurement of Work. NY: John Wiley and Sons - 1985 - 8th Edition*
2. *'Introduction to Work Study' - International Labor Office, Geneva - 1992 - 4th Edition*

REFERENCE BOOKS:

1. *Khanna O. P. – 'Industrial Engineering and Management' – Dhanpat Rai and Sons - 2007*
2. *Mahajan M. - 'Industrial Engineering and Production Management' - Dhanpat Rai and Sons Publishers - 2005*

15MEC335 LEAN MANUFACTURING 3 0 0 3

Unit 1

Introduction to Lean and Factory Simulation: History of Lean and comparison to other methods - The 7 Wastes, their causes and the effects - An overview of Lean Principles / concepts / tools - Stockless Production.

The Tools of Lean Manufacturing: Continuous Flow - Continuous Flow Manufacturing and Standard Work Flow - 5S and Pull Systems (Kanban and ConWIP systems) -

Error Proofing and Set-up Reduction – Total Productive Maintenance (TPM) - Kaizen Event examples. Toyota production systems, Ford production systems

Unit 2

Value Stream Mapping – Current state: Preparation for building a Current State Value Stream Map - Building a Current State Map (principles, concepts, loops, and methodology) - Application to the factory Simulation scenario.

Unit 3

Value Stream Mapping – Future State: Key issues in building the Future State Map - Process tips in building the map and analysis of the customer loop, supplier loop, manufacturing loop and information loop - Example of completed Future State Maps - Application to factory simulation – Implementation of lean practices - Best Practices in Lean Manufacturing.

TEXTBOOKS:

1. *Womack J. P., Jones D.T. and Roos D. - 'The Machine that Changed the World: the Story of Lean Production' - Simon & Schuster, New York - 1996*
2. *Liker J. K. - 'Becoming Lean' - Industrial Engineering and Management Press - 1998*

REFERENCES:

1. *Womack J. P. and Jones D. T. - 'Lean Thinking' - Simon & Schuster, USA - 1996*
2. *Rother M. and Shook J. - 'Learning to See' - The Lean Enterprise Institute, Brookline, USA - 2003*

15MEC336 MANAGERIAL STATISTICS 3 0 0 3

Unit 1

Quantitative methods: Basic terminology in probability, probability rules, conditions of statistical dependence and independence, Bayes Theorem, Discrete Random Variables review of probability distributions, measure of central tendency.

Sampling and sampling distributions: Introduction to sampling, random sampling, design of experiments, introduction to sampling distributions.

Estimation: point estimates, interval estimates and confidence intervals, calculating interval estimates of mean from large samples, using t test, sample size estimation.

Unit 2

Testing hypothesis: Introduction, basic concepts, testing hypothesis, testing when population standard deviation is known and not known, two sample tests.

Chi-square and analysis of variance: introduction, goodness of fit, analysis of variance, inferences about a population variation.

Unit 3

Regression and correlation: Estimation using regression line, correlation analysis, finding multiple regression equation, modelling techniques,

Non parametric methods and time series and forecasting: Sign test for paired data, rank sum test, rank correlation, Kolmogrov – smirnov test, variations in time series, trend analysis, cyclic variation, seasonal variation and irregular variation. Decision theory: Decision tree analysis.

TEXTBOOKS:

1. *Levin R. I. and Rubin D. S. - 'Statistics for management' - Pearson Education – 2007 - 5th Edition*
2. *Montgomery D. C. and Runger G. C. - 'Applied Statistics and Probability for Engineers' - John Wiley & Sons - 2002 - 3rd Edition*

REFERENCES:

1. *Bain.L. J. and Engelhardt M. - 'Introduction to Probability and Mathematical Statistics' - Duxbury Press - March 2000 - 2nd Edition*
2. *Hinkelmann K. and Kempthorne O. - 'Design and Analysis of Experiments : Volume I' - John Wiley & Sons, Inc. - December 2007 - 2nd Edition*
3. *Johnson R. A. and Wichern D. W. - 'Applied Multivariate Statistical Analysis' - Prentice-Hall, Inc. - December 2001 - 5th Edition*
4. *Myers R. H. - 'Classical and Modern Regression with Applications' - PWS-Kent Publishing Company - March 2000 - 2nd Edition*
5. *Devore J. L. - 'Probability and Statistics for Engineering and the Sciences' - Brooks/Cole Publishing Company - December 1999 - 5th Edition*
6. *Freund J. E. and Walpole R. E. - 'Mathematical Statistics' - Prentice-Hall Inc. - October 1986 - 4th Edition*

15MEC337 MARKETING MANAGEMENT 3 0 0 3

Unit 1

Marketing Process: Definition, Marketing process, dynamics, needs, wants and demands, value and satisfaction, marketing concepts, environment, mix. Philosophies, selling versus marketing, organizations, industrial versus consumer marketing, consumer goods, industrial goods, product hierarchy.

Buying Behaviour and Market Segmentation: Major factors influencing buying behaviour, buying decision process, business buying behaviour. Segmenting consumer and business markets, market targeting.

Unit 2

Product Pricing and Marketing Research: Objectives, pricing, decisions and pricing methods, pricing management. Introduction, uses, process of marketing research.

Unit 3

Marketing Planning and Strategy Formulation: Components of marketing plan-strategy formulations and the marketing process, implementations, portfolio analysis, BCG, GEC grids.

Advertising Sales Promotion and Distribution: Characteristics, impact, goals, types, and sales promotions - point of purchase - unique selling proposition. Characteristics, wholesaling, retailing, channel design, logistics, and modern trends in retailing.

TEXTBOOKS:

1. *Kolter P. - 'Marketing Management' - Pearson Education - 2014*
2. *Ramasamy and Namakumari, - 'Marketing Environment: Planning, Implementation and Control to the Indian Context' - 1990*

REFERENCES:

1. *Paul G. E. and Tull D. - 'Research for Marketing Decisions' - Prentice Hall of India - 1975*
2. *Tull D. S. and Hawkins - 'Marketing Research' - Prentice Hall of India – 1997*
3. *Kotler P. and Armstrong G. - 'Principles of Marketing' - Prentice Hall of India - 2000*
4. *Skinner S. J. - 'Marketing' - All India Publishers and Distributes Ltd. - 1998*
5. *Govindarajan, M. - 'Industrial Marketing Management' - Vikas Publishing Pvt. Ltd. - 2003*

15MEC338 OPERATIONS MANAGEMENT 3 0 0 3

Unit 1

Process Management: Process design - Process Re-engineering - Job design. Work standards – Work measurement - Work sampling.

Facility location: Plant Location - Factors affecting Location – Globalization. Layout planning – types - Designing of Process layout and Product layout.

Unit 2

Supply Chain Management: Over view – purchasing and distribution – Measures of supply chain performance - Supply chain dynamics.

Quality engineering: TQM, Six sigma concepts - Lean manufacturing, ISO standards.

Unit 3

Forecasting: Forecasting system - Judgment methods, Time series methods.

Capacity Planning: Aggregate planning: Importance – planning process. Material Requirements Planning - Inputs, Factors, Outputs. Master Production Scheduling. Scheduling – Gantt charts.

TEXTBOOKS:

1. *Krajewski L. J. And Ritzman L. P. - 'Operations Management: Strategy and Analysis' - Addison - Wesley Pearson Education Asia - 2010*
2. *Chase B. R. and Aquilano N. J. - 'Production and operations management' – McGraw Hill - 2006 - 7th Edition*

REFERENCES:

1. *Hopp W. J. and Spearman M. L. - 'Factory Physics' – McGraw Hill - 2000 - 2nd Edition*
2. *Buffa E. S. and Sariss R K. -'Modern Production / Operations Management' - John Wiley - 1994 - 8th Edition*

15MEC339 PROJECT MANAGEMENT 3 0 0 3

Unit 1

Foundations of Project Management: Project Life Cycle - Project Environment - Project Selection - Project Proposal - Project Scope - Work Breakdown Structure.

Network Scheduling: Critical Path Method, Project Evaluation & Review Technique - Planning and Scheduling of Activity Networks -Assumptions in PERT Modelling – Time-cost Trade-offs – Linear Programming and Network Flow Formulations - PERT/CPM.

Unit 2

Scheduling with limited resources: Resource Planning - Resource allocation - Project Schedule Compression - Project Scheduling Software. Precedence Diagrams - Decision CPM - Generalized Activity Networks - GERT.

Unit 3

Estimation of Project Costs: Earned Value Analysis. Monitoring Project Progress. Project Appraisal and Selection - Recent Trends in Project Management.

TEXTBOOK:

Meredith Jack R. and Samuel J. Mantel Jr. - 'Project Management- A Managerial Approach' - John Wiley - 1995

REFERENCES:

1. *Ted K. - 'Project Management, Tools, and Trade-offs' - John Wiley - 2004*
2. *Samuel J. M. and Meredith J. R. - 'Core Concepts of Project Management' - John Wiley - 2001*

15MEC340 SUPPLY CHAIN MANAGEMENT 3 0 0 3

Unit 1

Introduction: Introduction to SCM - the complexity and key issues in SCM – Location strategy – facility location decisions – single facility and multiple location models.

Logistics: Logistics Network Configuration – data collection - model and data validation - solution techniques - network configuration DSS – Transport strategy – Service choices: single service and inter modal services – vehicle routing and scheduling models – traveling salesman problems – exact and heuristic methods.

Unit 2

Inventory: Inventory Management and risk pooling - managing inventory in the SC. Value of Information - bullwhip effect - lead time reduction.

Supply Chain Integration: Supply chain integration - distributed strategies - push versus pull systems.

Distribution Requirements Planning – DRP and demand forecasting, DRP and master production scheduling. DRP techniques – time-phased order point – managing variations in DRP – safety stock determination - Strategic alliances - third party logistics - distribution integration.

Unit 3

Issues in SCM: Procurement and outsourcing strategies – framework of e-procurement. International issues in SCM - regional differences in logistics. Coordinated product and supply chain design - customer value and SCM.

TEXTBOOK:

1. Simchi D. and Levi - 'Designing and Managing the Supply Chain: Concepts, Strategies and Cases' - McGraw Hill - 2002

2. Christopher M. - 'Logistics and Supply Chain Management: Strategies for Reducing Cost and Improving Service' – PH - 1999

REFERENCES:

1. Ballou M. - 'Business logistics / Supply chain management' - Pearson Education - 2003

2. Vollmann T. E. - 'Manufacturing Planning and Control for Supply Chain Management' - McGraw Hill – 2005 - 5th Edition

15MEC341 TOTAL QUALITY MANAGEMENT 3 0 0 3

Unit 1

Definition of quality - dimensions of quality. Quality planning - quality costs. Total Quality Management: historical review and principles –leadership - quality council - quality statements - strategic planning - Deming philosophy. Barriers to TQM implementation.

Unit 2

Customer satisfaction – Customer retention - Employee involvement - Performance

appraisal - Continuous process improvement - Supplier partnership - Performance measures. Seven tools of quality.

Statistical fundamentals - Control Charts for variables and attributes - Process capability - Concept of six sigma - New seven management tools - Benchmarking.

Unit 3

Quality function deployment (QFD) - Taguchi quality loss function - Total Productive Maintenance (TPM) - FMEA.

Need for quality systems - ISO 9000:2000 – Elements of quality systems (such as ISO 9000:2000). Implementation of quality system – documentation - quality auditing - QS 9000-ISO 14000.

TEXTBOOK:

Besterfiled D. H. - 'Total Quality Management' - Pearson Education Asia - 2005

REFERNCES:

1. *Evans J. R, and Lidsay W. M. - 'The Management and Control of Quality' - Southwestern (Thomson Learning) - 2002 - 5th Edition*
2. *Feigenbaum A. V. - 'Total Quality Management - Vol I & II ' – McGraw Hill - 1991*

15MEC381 MANUFACTURING PROCESS LAB. 0 0 2 1

Study of types of lathes and their accessories, selection of cutting parameters. Exercises on plain turning, step turning, taper turning, knurling & chamfering, thread cutting, plain milling, end milling, shaping machines - slab & slot cutting, study of grinding machines - surface grinding and cylindrical grinding, study of drilling machines, exercises on drilling machine - drilling, boring, reaming, counter boring, counter sinking & tapping. Measurement of cutting force.

Study of various processes, tools and equipment's used in foundry, exercises on mould preparation, foundry sand testing.

15MEC382 THERMAL SCIENCES LAB. 0 0 2 1

Experiments to determine flash and fire point, viscosity, calorific values of solid, liquid and gaseous fuels, Carbon content (Carbon residue test).

Study of I.C engines, components and loading devices, Valve timing and port timing diagrams, Performance test, Heat balance sheet on Petrol and Diesel engines, to find Friction power: Morse test or Motoring test.

Study of Refrigeration and Air conditioning system - Performance Tests (COP), Study of Renewable energy systems (like Solar, Wind, Biomass etc.) - Performance tests.

15MEC385 HEAT TRANSFER AND THERMAL ANALYSIS LAB. 0 0 2 1

HEAT TRANSFER

To determine of thermal conductivity of metal rod and composite wall, heat transfer coefficient in free and forced convection. Performance test on extended surfaces, heat exchangers.Experiment on Transient conduction and radiation heat transfer.

THERMAL ANALYSIS

Introduction to the Software package, Analysis of flow through pipes, elbows and nozzles,Analysis of flow over different objects using CFD software,Analysis of conduction, convection and radiation problems using FEM package

15MEC386 METROLOGY AND MEASUREMENTS LAB. 0 0 2 1

METROLOGY LAB

LINEAR AND ANGULAR MEASUREMENTS: Slip gauges, Micrometers, Verniers, Dial gauges and Surface plates – Comparators: Mechanical, Electrical, Pneumatic and Optical comparator. Angular measuring instruments - Sine bar, Angle gauges, Spirit level, Auto collimators.

MEASUREMENT OF SURFACE FINISH AND MEASURING MACHINES: Surface finish: Definitions - Types of Surface texture: Surface roughness, Measurement of run out and concentricity, Optical projection comparator - Tool makers microscope.

MEASUREMENT OF SCREW THREADS AND GEARS: Internal / External Screw thread: Terminology, Measurement of various elements of threads - Thread micrometer method, Gear Terminology, Measurement of various elements.

MEASUREMENTS LAB

Calibration of Pressure Gauge, Thermocouple, LVDT, Load cell. Measurement of load, torque, speed, angular displacement. Study of strain gauge rosettes, determination of modulus of elasticity using strain gauges. Study of stress concentration using photo-elasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression.

15MEC390 / 15MEC490 LIVE-IN-LAB. 3 cr

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or

rural sites during the vacations (after 4th semester or sixth semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth or seventh semester. The objectives and projected outcome of the project should be reviewed and approved by the Dept. chairperson and a faculty assigned as the project guide. On completion of the project, the student shall submit a detailed project report. The report shall be evaluated and the students shall appear for a viva-voce test on the project.

15MEC401 ADVANCED FLUID MECHANICS 3 0 0 3

Unit 1

Differential analysis of fluid flow. Conservation of mass - the continuity equation. The stream function. The stream function in Cartesian coordinates. The stream function in cylindrical coordinates. The differential linear momentum equation - Cauchy's equation. The Navier- Stoke's equation. Derivation of Navier-Stoke's equation for incompressible, isothermal flow. Differential analysis of fluid flow problems.

Unit 2

The boundary layer equations. Displacement thickness. Momentum thickness. Turbulent flat plate boundary layer. Boundary layers with pressure gradients.

Drag and lift. Friction and pressure drag. Drag coefficients of common geometries. Parallel flow over flat plates. Flow over cylinders and spheres. Lift.

Unit 3

Compressible Flow. Stagnation properties. One dimensional isentropic flow. Isentropic flow through nozzles. Shock waves and expansion waves. Duct flow with heat transfer and negligible friction (Rayleigh flow). Adiabatic duct flow with friction.

TEXTBOOKS:

1. *Fox and McDonald - 'Fluid Mechanics' - John Wiley - 2011 - 8th Edition*
2. *White F. M. - 'Fluid Mechanics' - McGraw Hill International Edition - 2010 - 7th Edition*

REFERENCES:

1. *Panton R. L. - 'Incompressible Flow' - Wiley India, 2013 - 4th Edition*
2. *Cengel Y. A. and Cimbala J. M. - 'Fluid Mechanics (Fundamentals and Applications)' - The McGraw Hill, India - 2013 - 3rd Edition*

15MEC402 CONTROL ENGINEERING 3 0 0 3

Unit 1

Introduction: Concept of automatic controls, open and closed loop systems, concepts of feedback, requirement of an ideal control system.

Modeling of Systems: The control system, Mathematical models of physical systems - Introduction, Differential equations of physical systems – Mathematical Model: Mechanical System (both translation and rotational), Electrical systems (servos, D.C. Motors, A.C. Servomotors), Hydraulic systems (liquid level and fluid power systems), Thermal systems, Integrating devices, Hydraulic servomotor, temperature control system, error detectors.

Block Diagrams: Transfer Functions definition, function, block representation of system elements, reduction of block diagrams, Basic properties and gain formula to block.

Unit 2

System Response: First order and second order system response to step, ramp and sinusoidal inputs, concepts of time constant and its importance in speed of response

Stability analysis: Concepts of stability, Necessary conditions for Stability, Routh-stability criterion, Relative stability analysis; Effect of proportional, integral and derivative control actions, steady state errors in unity feedback control systems Root–Locus Techniques: Introduction, The root locus concepts, Construction of root loci, lead compensation, lag compensation and lag-lead compensation

Unit 3

System Analysis using Logarithmic plots: Bode attenuation diagrams, Stability Analysis using Bode diagrams, Simplified Bode Diagrams.

Control system analysis in state space: Introduction to the state concepts, state equation of linear continuous data system. Matrix representation of state equations, controllability and observability, Kalman and Gilberts test

TEXTBOOKS:

1. *K. Ogata - 'Modern Control Engineering - Prentice Hall (India) - Pearson Education - 2009 - 5th Edition*
2. *Francis. H. Raven - 'Automatic Control Systems' – McGraw Hill - 1995 - 5th Edition*

REFERENCES:

1. *B. C. Kuo - 'Automatic Control Systems' - Wiley - 2009 - 9th Edition*
2. *Schaum's Series - 'Feedback and Control Systems' – McGraw Hill Education - 2013 - 2nd Edition*
3. *I. J. Nagarath & M. Gopal - 'Control Systems' - New age International Publishers.*
4. *Norman Nise- 'Control Systems Engineering' - Wiley and Sons - 2015 - 7thEdition*
5. *Rihard C. Drof and Robert. H. Bishop Addison - 'Modern Control Systems' – Wesley – 2010 - 12th Edition*

15MEC403 INDUSTRIAL ROBOTICS 3 0 0 3

Unit 1

Evolution of robotics. Robot anatomy - Design and control issues. Manipulation and Control - Sensors and Vision.

Coordinate frames. Mapping: Mapping between rotated frames - Mapping between translated frames - Mapping between rotated and translated frames - Description of objects in space - Transformation of vectors – Rotation - translation combined with rotation - translation of vectors - composite transformation - Inverting a homogenous transform - Fundamental rotational matrices.

Unit 2

Direct Kinematic Model – Mechanical structure and notations - Description of links and joints - Kinematic modeling of manipulator - Denavit-Hartenberg Notation - Kinematic Relationship between adjacent links - Manipulator Transformation Matrix.

Inverse Kinematic Model – Manipulator Workspace – Solvability - Solution techniques - Closed form solution.

Unit 3

Imaging components - image representation - picture coding - object recognition and categorization - visual inspection. Robot cell - design and control layouts. Industrial Applications – Material Handling, Process, Assembly, Inspection. Non-Industrial Applications.

TEXTBOOK:

Fu, K. S., Gonzalez, R. C. and Lee C. S. G. - 'Robotics: Control, Sensing, Vision, and Intelligence' – McGraw Hill, New York, NY - 1987

REFERENCE BOOKS:

1. *Mittal R. K. and Nagrath, I. J. - 'Robotics and Control' - Tata McGraw Hill Publishing Company Limited, New Delhi - 2004.*
2. *Craig, J. - 'Introduction to Robotics: Mechanics and Control' - Prentice Hall - 2004 - 3rd Edition*
3. *Peter Corke - 'Robotics, Vision and Control: Fundamental Algorithms in MATLAB' - Springer - 2009*

15MEC404 MECHANICAL VIBRATIONS 3 0 0 3

Unit 1

Introduction: Types of vibrations, Simple Harmonic Motion (SHM), principle of super position applied to Simple Harmonic Motions. Beats, Fourier theorem and simple problems.

Un-damped free vibrations: Single degree of freedom systems. Un-damped free vibration-natural frequency of free vibration, stiffness of spring elements, effect of mass of spring, Compound Pendulum.

Damped free vibrations: Single degree freedom systems, different types of damping, concept of critical damping and its importance, study of response of viscous damped systems for cases of under damping, critical and over damping, Logarithmic decrement.

Unit 2

Forced Vibration: Single degree freedom systems, steady state solution with viscous damping due to harmonic force. Solution by Complex algebra, Reciprocating and rotating unbalance, vibration isolation - transmissibility ratio. Due to harmonic excitation and support motion, Whirling of Shafts - Whirling of shafts with and without air damping, Discussion of speeds above and below critical speeds.

Vibration measuring instruments & Vibration Control: Vibration exciters, vibrometer and accelerometer, free & forced vibration tests, vibration isolation, vibration absorbers.

Unit 3

Systems with two degrees of freedom: Introduction, principle modes and Normal modes of vibration, co-ordinate coupling, generalized and principal co-ordinates, Free vibration in terms of initial conditions. Geared systems. Forced Oscillations - Harmonic excitation.

Multi degree of freedom systems: Introduction, Influence coefficients, Maxwell reciprocal theorem, Dunkerley's equation. Orthogonality of principal modes, Method of matrix iteration - Method of determination of all the natural frequencies using sweeping matrix and Orthogonality principle. Holzer's method, Stodola method. Rayleigh's method.

TEXTBOOKS:

1. *W. T. Thomson and Marie Dillon Dahleh - 'Theory of Vibration with Applications' - Pearson Education - 2007 - 5th Edition*
2. *S. S. Rao - 'Mechanical Vibrations' - Pearson Education Inc. - 2011 - 5th Edition*

REFERENCES:

1. *V. P. Singh, - 'Mechanical Vibrations' – Dhanpat Rai & Company Pvt. Ltd. - 2014 - 3rd Edition*
2. *S. Graham Kelly - 'Mechanical Vibrations' - Schaum's Outline Series - Tata McGraw Hill - 2011 - Special Indian Edition*
3. *Leonanrd Meirovitch - 'Elements of Vibrations Analysis' - Tata McGraw Hill - 2007 - Special Indian Edition*

15MEC411 OPERATIONS RESEARCH 3 0 0 3

Unit 1
Linear programming: Formulations - graphical solutions, simplex method, duality, Transportation model, Assignment model-travelling salesman problem.

Unit 2
Decision theory: Decision trees. Game theory - two persons zero sum, mixed strategies; 2 x n and m x 2. Network models - project networks - CPM/PERT, project scheduling, crashing networks and cost considerations, resource levelling and smoothing, shortest route problem, minimal spanning tree problem, maximal flow problem.

Unit 3
Sequencing model - 2 machines n jobs, m machines n jobs-n jobs 2 machines.

Inventory models - deterministic and probabilistic models, Queuing models-poison arrival and exponential service times, single server, multi-server. Simulation: Monte Carlo simulation - simple problems.

TEXTBOOK:

Wagner, H. M. - 'Principles of Operations Research - Prentice Hall, New Delhi - 1998

REFERENCES:

1. *J. K. Sharma. - 'Operations Research Theory and Applications' - Macmillan India Ltd, New Delhi - 2013 - 5th Edition*
2. *Taha H. A. - 'Operations Research: An Introduction' - Prentice Hall, New Delhi - 2010 - 9th Edition*
3. *Ravindra A., Phillips, D. J. and Solberg, J. J. - 'Operations Research - Principles and Practice' - John Wiley & Sons - 2005.*
4. *Hadley G - 'Linear Programming' - Narosa Book Distributors Private Ltd. - 2006*

15MEC481 COMPUTER INTEGRATED MANUFACTURING LAB. 0 0 2 1

CNC Part Programming using CAM packages, Simulation of Turning, Drilling and Milling Operations through Manual Part Programming.

Robot Programming using Teach Pendent and Offline Programming to Perform Pick and Place, Stacking of Objects.

Logical Circuits - Pneumatic and Electro-Pneumatic Circuits, Study of PLC and PLC based Electro-Pneumatic Sequencing Circuits, Visual Inspection of Objects by Computer Vision Technology.

15MEC482 MACHINE DYNAMICS AND CONTROL LAB. 0 0 2 1

Experiments on balancing of reciprocating and rotating masses. Determination of gyroscopic couple, study of governors. Experiments on free vibrations: Bifilar, trifilar, compound pendulums. Damping: damping, and critical damping coefficients, logarithmic decrement, coulomb damping, Natural frequencies of coupled, pendulum. Determination of critical speed of shafts.

Experiments on level, position and speed control. Study of time response of I and II order systems. Analysis of control systems using software packages – exercise on root locus and bode plots.

15MEC495 PROJECT PHASE I 2 cr

The students are required to freeze the area of their project work and conduct the literature surveys during Phase-I of the project, under the guidance of any faculty in the department. The students are expected to work on a topic in the field of Mechanical Engineering. They will be evaluated based on the presentations made by them and a report submitted at the end of the semester by a committee of examiners appointed by the Chairman of the Department.

15MEC499 PROJECT PHASE II 10 cr

The project should be focused on the synthesis of knowledge gained over the past seven semesters and Phase-I of the project. The project should be relevant to Mechanical Engineering which could involve theoretical and / or computational and / or fabrication and/ or experimental work. Students are required to submit a report at the end of the semester. Evaluation will be done during the course of the project as well as at the end of the semester by a committee of examiners appointed by the Chairman of the Department.

15PHY100 PHYSICS 3 0 0 3

Unit 1 Review of Classical Physics and dual nature of Waves /particle
Review of Kinematics, Force, Newton's Laws, Linear Momentum, Work, Energy, Power, Angular Motion - Kinematics and Mechanics, Angular momentum Torque, Conservation laws (linear and angular).

Particle properties of waves: Photoelectric effect, quantum theory of light, X-ray diffraction, Compton effect, pair production. Wave properties of particles: Waves, De Broglie waves, Group velocity and phase velocity, uncertainty principle.

Unit 2 Atomic Structure and Quantum Mechanics

Atomic Structure: Various models of atom, Atomic Spectra, Energy Levels, Correspondence Principle, Nuclear Motion, Atomic Excitation, and Rutherford Scattering.

Quantum Mechanics: Introduction - wave equation - Schrodinger's equation (time dependent and independent) - expectation values, operators, Eigen value (momentum and energy) – 1D potential box (finite and infinite) - tunnel effect - harmonic oscillator.

Unit 3 Statistical Mechanics and Solid State Physics

Statistical Mechanics: Classical Distribution - Maxwell's Boltzmann-Molecular energies of an ideal gas - most probable speed. Quantum Statistics - Bose-Einstein and Fermi-Dirac. Applications - Black Body Radiation, Specific heat of solids, free electrons in metals, Electron energy.

Solid State Physics: Types of solids, Crystallography, Bonds- Ionics, Covalent, and Van der Waals, Band Theory and energies, Semiconductor Devices, and Superconductivity.

TEXTBOOK:

"Concept of Modern Physics", Arthur Beiser, Tata-McGraw Hill, edition.

REFERENCE BOOK:

"Principles of Physics" by Halliday, Resnick and Walker, 9th edition

15PHY181 PHYSICS LAB. 0 0 2 1

Young's Modulus – Non Uniform Bending
Newton's Rings
Laser - Determination of Wavelength and Particle Size Determination
Spectrometer
Carey Foster's Bridge
Rigidity Modulus - Tensional Pendulum
Viscosity of Liquid by Stokes's method
Ultrasonic Interferometer
Hysteresis – B H curve

15PHY230 ADVANCED CLASSICAL DYNAMICS 3 0 0 3

Unit 1

Introduction to Lagrangian dynamics

Survey of principles, mechanics of particles, mechanics of system of particles, constraints, D'Alembert's principle and Lagrange's equation, simple applications of

the Lagrangian formulation, variational principles and Lagrange's equations, Hamilton's principles, derivation of Lagrange's equations from Hamilton's principle, conservation theorems and symmetry properties.

Unit 2

Central field problem

Two body central force problem, reduction to the equivalent one body problem, Kepler problem, inverse square law of force, motion in time in Kepler's problem, scattering in central force field, transformation of the scattering to laboratory system, Rutherford scattering, the three body problem.

Rotational kinematics and dynamics

Kinematics of rigid body motion, orthogonal transformation, Euler's theorem on the motion of a rigid body.

Unit 3

Angular momentum and kinetic energy of motion about a point, Euler equations of motion, force free motion of rigid body.

Practical rigid body problems

Heavy symmetrical spinning top, satellite dynamics, torque-free motion, stability of torque-free motion - dual-spin spacecraft, satellite maneouvering and attitude control - coning maneuver - Yo-yo despin mechanism - gyroscopic attitude control, gravity-gradient stabilization.

TEXTBOOKS:

1. *H. Goldstein, Classical Mechanics, Narosa Publishing House, New Delhi, 1980, (Second Edition)*
2. *H. Goldstein, Charles Poole, John Safko, Classical Mechanics, Pearson education, 2002 (Third Edition)*
3. *Howard D. Curtis, Orbital Mechanics for Engineering Students, Elsevier, pp.475 - 543*
4. *Anderson John D, Modern Compressible flow, McGraw Hill.*

REFERENCE BOOKS:

1. *D. A. Walls, Lagrangian Mechanics, Schaum Series, McGraw Hill, 1967.*
2. *J. B. Marion and S. T. Thornton, Classical dynamics of particles and systems, Ft. Worth, TX: Saunders, 1995.*

15PHY233 BIOPHYSICS AND BIOMATERIALS 3 0 0 3

OBJECTIVE: *To equip the students with the knowledge on different kinds of biomaterials and other medical need, basic research, and to provide an over view of theory and practice of bio materials.*

Unit 1

Quantum mechanics – Schrodinger's time dependent and independent equations – Pauli's exclusion principle – ionization energy – electron affinity – chemical binding – electro negativity and strong bonds - secondary bonds – inter atomic potential or strong bonds and weak bonds – bond energies – spring constants – free energy – internal energy – reaction kinetics.

Definition and classification of bio-materials, mechanical properties, visco-elasticity, wound-healing process, Application of biomaterial for the human body, body response to implants, blood compatibility. Implementation problems - inflammation, rejection, corrosion, structural failure. Surface modifications for improved compatibility.

Unit 2

Bioceramics, Biopolymers, Metals, ceramics and composites in medicine: Properties, applications, suitability & modifications required for certain applications.

X-ray diffraction and molecular structure – Nuclear Magnetic Resonance – scanning tunneling microscope – Atomic force microscopy – optical tweezers – patch clamping – molecular dynamics – potential energy contour tracing – SEM – TEM – spectroscopy methods differential thermal analysis, differential thermo gravimetric analysis – NDT methods.

Unit 3

Materials for bone and joint replacement – dental metals and alloys – ceramic – bioinert – bioactive ceramics – polymers - dental restorative materials – dental amalgams – cardiovascular materials – cardiac prosthesis; vascular graft materials – cardiac pacemakers – cardiac assist devices – materials for ophthalmology contact lens – intraoccular materials – materials for drug delivery.

TEXTBOOKS AND REFERENCES:

1. *Rodney M J Cotterill, Biophysics an introduction, John Wiley & sons Ltd., NY, 2002*
2. *Vasantha Pattabhi and N.Gautham, Biophysics, Alpha science International Ltd. UK, 2002.*
3. *Jonathan Black, Biological Performance of Materials, Fundamentals of Biocompatibility, Marcel Dekker Inc., New York, 1992.*
4. *D. F. Williams (ed.), Material Science and Technology - A comprehensive treatment, Vol.14, Medical and Dental Materials, VCH Publishers Inc., New York, 1992.*
5. *H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis, CBS Publishers, New Delhi, 1986.*

15PHY234 INTRODUCTION TO COMPUTATIONAL PHYSICS 3 0 0 3

Unit 1

Differentiation: Numerical methods, forward difference and central difference methods, Lagrange's interpolation method.
Integration: Newton - cotes expression for integral, trapezoidal rule, Simpsons's rule, Gauss quadrature method.

Unit 2

Solution of differential equations: Taylor series method, Euler method, Runge Kutta method, predictor-corrector method.

Roots of equations: Polynomial equations, graphical methods, bisectional method, Newton-Raphson method, false position method.

Unit 3

Solution of simultaneous equations: Elimination method for solving simultaneous linear equations, Gauss elimination method, pivotal condensation method, Gauss-seidal iteration method, Gauss Jordan method, matrix inversion method.

Eigen values and Eigen vectors of matrix: Determinant of a matrix, characteristic equation of a matrix, eigen values and eigen vectors of a matrix, power method.

TEXTBOOK:

Rubin H Landau & Manuel Jose Paez Mejia, "Computational Physics", John Wiley & Sons

REFERENCES:

Suresh Chandra, "Computer Applications in Physics", Narosa Publishing House, New Delhi
M Hijroth Jensen, Department of Physics, University of Oslo, 2003 (Available in the Web)

15PHY238 ELECTRICAL ENGINEERING MATERIALS 3 0 0 3

Unit 1

Conducting materials: The nature of chemical bond, crystal structure Ohm's law and the relaxation time, collision time, electron scattering and resistivity of metals, heat developed in a current carrying conductor, thermal conductivity of metals, superconductivity.

Semiconducting materials: Classifying materials as semiconductors, chemical bonds in Si and Ge and it's consequences, density of carriers in intrinsic semiconductors, conductivity of intrinsic semiconductors, carrier densities in n type semiconductors, n type semiconductors, Hall effect and carrier density.

Unit 2

Magnetic materials: Classification of magnetic materials, diamagnetism, origin of permanent, magnetic dipoles in matter, paramagnetic spin systems, spontaneous magnetization and Curie Weiss law, ferromagnetic domains and coercive force, anti-ferromagnetic materials, ferrites and it's applications.

Unit 3

Dielectric materials: Static dielectric constant, polarization and dielectric constant, internal field in solids and liquids, spontaneous polarization, piezoelectricity.

PN junction: Drift currents and diffusion currents, continuity equation for minority carriers, quantitative treatment of the p-n junction rectifier, the n-p-n transistor.

TEXTBOOK:

A J Decker, "Electrical Engineering materials", PHI, New Delhi, 1957.

REFERENCES:

1. *A J Decker, "Solid State Physics", Prentice Hall, Englewood Cliffs, N J 1957.*
2. *C Kittel, "Introduction to solid state Physics", Wieley, New York, 1956 (2nd edition).*
3. *Allison, Electronic Engineering materials and Devices, Tata McGraw Hill*
4. *F K Richtmyer E H Kennard, John N Copper, "Modern Physics", Tata McGraw Hill, 1995 (5th edition).*

15PHY239 ELECTROMAGNETIC FIELDS AND WAVES 3 0 0 3

Unit 1

Electrostatics: Coulombs law and electric field intensity, field due to a continuous volume charge distribution, field of a line charge, field of sheet of charge, electric flux density, Gauss's law, application of Gauss's law, Maxwell's first equation.
Poisson's and Laplace's equations: The potential field of a point charge, potential field of a system of charges: conservative property, potential gradient, the dipole.

Unit 2

Poisson's and Laplace's equations, uniqueness theorem, examples of the solution of Laplace's equation, solution of Poisson's equation.

Electromagnetics: Biot Savart law, magnetic flux and magnetic flux density, scalar and vector magnetic potentials, derivation of steady magnetic field laws, Faraday's laws, displacement current, Maxwells equations in point and integral form, retarded potentials

Unit 3

Electromagnetic waves: EM wave motion in free space, wave motion in perfect dielectrics, plane wave in lossy dielectrics, Poynting vector and power consideration, skin effect, reflection of uniform plane waves, standing wave ratio.

Transmission line equations, line parameters - examples, dipole radiation, retarded potentials, electric dipole radiation.

TEXTBOOK:

William H Hayt, "Engineering Electromagnetics", Tata McGraw Hill, New Delhi, 2002 (5th edition).

REFRENCES:

1. *David J Griffiths, "Introduction to Electrodyanamics", Prentice-Hall of India, New Delhi, 1999 (2nd edition).*
2. *J D Jackson, "Classical Electrodynamics", Wiley Eastern, 2004 (2nd edition).*
3. *B. Chakraborty, "Principles of Electrodynamics", Books and Allied Publishers, 2002*

15PHY240 ELECTRONIC MATERIAL SCIENCES 3 0 0 3

Unit 1

Types of bonding in solids, Crystallography and crystalline defects: Crystallography, Directions and planes, Crystalline defects, line defects, Planar defects, Volume defects; Binary and Ternary Phase Diagrams: Lever rule and phase rule, Eutectic, peretectic and Eutectoid systems, Applications of Phase diagrams; Basic Quantum Physics - atomic structure, Use of band theory and occupation statistics to explain existence and basic properties of metals and nonmetals. Working of Semiconductor Devices using band diagrams and their electrical characteristics: pn junctions, BJT, MOSFET.

Unit 2

Useof band theory to explain optoelectronic properties of materials and optoelectronic devices: LEDs, Solar Cells, Lasers, pin diodes, photodiodes; Magnetic properties and Superconductivity: Magnetic moments and Magnetic Permeability, types of magnetism, saturation magnetization, magnetic domains, soft and hard magnetic materials, superconductivity and its origin, Giant Magneto Resistance, Josephson effect, Energy band diagrams and Magnetism, Applications of magnetic materials - Magnetic recording materials, etc.

Unit 3

Optical Properties of Materials: Reflection, Refraction, Dispersion, Refractive Index, Snells Law, Light Absorption and Emission, Light Scattering, Luminescence, Polarization, Anisotropy, Birefringerence; Dielectric Properties of Materials: Polarization and Permittivity, Mechanisms of polarization, dielectric properties - dielectric constant, dielectric loss, dielectric strength and breakdown, Piezoelectricity, Ferreoelectricity, and Pyroelectricity, Dielectric Materials

TEXTBOOK:

S. O. Kasap, Principles of Electronic Materials and Devices, 2006, 3rd edition, Tata McGraw Hill.

REFERENCE:

D. Jiles: Introduction to the Electronic Properties of Materials, Chapman & Hall. 1994.

15PHY241 LASERS IN MATERIAL PROCESSING 3 0 0 3

Unit 1

Basic optical theory: Nature of electromagnetic radiation, interaction of radiation with matter, reflection, refraction, polarization, laser fundamentals, laser beam characteristics, beam quality (laser cavity modes),Q-switching, mode locking, continuous wave, types of lasers, energy and power.

Laser interaction with materials: Optical properties of materials,laser interaction with metals, insulators, semiconductors, polymers and biological materials.

Laser surface treatment: Introduction to laser surface hardening, laser surface melting, laser surface alloying, laser surface cladding, laser cleaning. Laser ablation: mechanisms (photothermal, photophysical and photochemical), mask projection techniques, laser micro and nano structuring.

Unit 2

Laser cutting and drilling: Mechanism for inert gas and oxygen-assisted cutting, factors controlling cut quality and kerf width. Laser assisted drilling.

Laser welding: Introduction to laser keyhole welding and contrast with conduction limited welding, applications,

Direct laser fabrication (DLF): Laser sintering & laser rapid manufacturing, comparison with rapid prototyping. Main potential and limitations of DLF for direct fabrication and for the production of novel engineering materials and structures.

Unit 3

Laser forming: Mechanisms involved, including thermal temperature gradient, buckling, upsetting. Applications in alignment and straightening and in rapid production processes.

Scope of application of laser materials processing: focused on industrial application of laser in materials processing including laser welded tailored blanks.

Laser safety: Introduction to safety procedures in the use of lasers, including wavelength effects and laser safety standards.

REFERENCES:

1. *Steen, W M, Laser Material Processing (3rd Edition), Springer Verlag, 2003, ISBN 1852336986.*

2. *Silvast, W T, Laser Fundamentals, Cambridge University Press, 1998, ISBN 0521556171.*
3. *J. F. Ready, D. F. Farson. LIA Handbook of Laser Materials Processing Laser Institute of America, 2001.*
4. *M. von Allmen. Laser-Beam Interactions with Materials, Springer, 1987*
5. *D. Bauerle. Laser Processing and Chemistry, Springer, 2000*
6. *W. W. Duley, UV lasers: effects and applications in materials science, Cambridge University, Press, Cambridge; New York, 1996.*
7. *J. Dutta Majumdar, and I. Manna, Laser Material Processing, Sadhana, Vol. 28, Year: 2003, 495-562.*

15PHY243 MICROELECTRONIC FABRICATION 3 0 0 3

Unit 1

Introduction to semiconductor fabrication – scaling trends of semiconductor devices; crystal structure of semiconductor materials, crystal defects, phase diagrams and solid solubility; physics of Czochralski growth of single crystal silicon, Bridgeman method for GaAs, float zone process; diffusion science: Ficks laws of diffusion, atomistic models of diffusion, dopant diffusion mechanisms; kinetics of thermal oxidation, Deal-Grove Model, nitridation of silicon, structure and characteristics of oxides, effect of dopants on oxidation kinetics, dopant redistribution;

Unit 2

Physics of ion implantation: Coulombic scattering and projected range, nuclear and electronic stopping, channeling, implantation damage removal, dopant activation by rapid thermal annealing; principles of optical lithography – optics and diffraction, light sources and spatial coherence, physics of pattern transfer, nodulation transfer function; chemistry of lithographic processes: organic and polymeric photoresists, developing and exposure, contrast; principles of non-optical lithography: electron beam, X-ray lithography, resists, sources; etching: Chemistry of wet etching, plasma physics, chemistry of plasma etching and reactive ion etching; chemical mechanical polishing.

Unit 3

Vacuum science: Kinetic theory of gases, gas flow and conductance, vacuum pumps and seals; deposition of thin films: physics of sputtering and evaporation, step coverage and morphology of deposited films, chemical vapor deposition: chemical equilibrium and law of mass action, gas flow and boundary layers, types of CVD, plasma assisted CVD; thermodynamics of epitaxial growth, types molecular beam epitaxy, isolation and contact formation – LOCOS and trench, silicides, metallization with Al and Cu; process Integration: CMOS, bipolar process flow.

TEXTBOOK:

Stephen Campbell, Science and Engineering of Microelectronic Fabrication, Oxford University Press, 2001

REFERENCE:

1. *S K Gandhi, VLSI Fabrication Principles, John Wiley & Sons, 1994*
2. *Gary S May and Simon M Sze, Fundamentals of Semiconductor Fabrication, John Wiley, 2003.*
3. *S Wolfe, Silicon Processing for the VLSI Era, Lattice Press, 1998.*

15PHY245 NUCLEAR ENERGY: PRINCIPLES AND APPLICATIONS 3 0 0 3

Unit 1

Basics: Atomic theory, nuclear composition, sizes and masses of nuclei, binding energy, radioactive decay, radioactive chains. Nuclear reactions, transmutation of elements, conservation laws, neutron cross sections, interaction of charged particles and gamma radiation with matter.

Fission and fusion: The fission process, energetic of fission, byproducts of fission, energy from nuclear fuels. Fusion reactions, electrostatic and nuclear forces, thermo nuclear reactions in plasma. Energetics of fusion. Comparison of fusion and fission reactions.

Unit 2

Neutron chain reactions and nuclear power: Criticality and multiplication, factors governing the multiplication, neutron flux and reactor power, reactor types and reactor operations. Methods of heat transmission and removal, steam generation and electric power generation, waste heat disposal.

Unit 3

Breeder reactors and fusion reactors: The concept of breeding nuclear fuel, isotope production and consumption, fast breeder reactor, breeding and uranium sources. Technical problems in the functioning of fusion reactor, requirements for practical fusion reactors, magnetic confinement, inertial confinements and other fusion concepts. Prospects of fusion power.

Radiation protection and waste disposal: Biological effects of radiation, radiation dose units, protective measures, internal exposure, and radon problem. Nuclear fuel cycle and waste classification, spent fuel storage and transportation, high level waste disposal, low level waste disposal.

TEXTBOOK:

Raymond L Murray, Nuclear Energy: An Introduction to the Concepts, Systems and Applications of Nuclear Processes, Butterworth-Heimann-Elsevier Inc (2009)

REFERENCES:

1. *David Bodansky, Nuclear Energy: principles, practices and prospects, Springer Verlag*
2. *S K Rajput, Nuclear Energy, Mahaveer & Sons (2009)*

15PHY247 PHOTOVOLTAICS 3 0 0 3

Unit 1

Introduction to semiconductors: Semiconductors: concept of electron and holes, conduction in semiconductors and concentration of charge carriers in semiconductors. Direct and indirect band gap semiconductors (quantum mechanical treatment). Extrinsic semiconductors: n-type, p-type & compensation doping, carrier concentration; PN junction - concept of bands at PN junction, junction under forward and reverse biases (conceptual).

Unit 2

Optical Processes: Optical absorption, Photoelectric Effect, Beer-Lambert law (Qualitative). Wavelength to band gap relation. Generation of electron-hole pairs. Recombination processes - direct and indirect recombination, other recombination processes - Shockley Reed Hall recombination, Auger recombination.

Solar Cell – Principle: Introduction & history of Solar cells. Constituents of solar radiations (Solar Spectrum). Separation of electrons and holes. Transport of charge carriers - diffusion & drift of carriers, continuity equation, field current, diffusion current, total charge current.

Unit 3

Solar Cell – Properties: Measurement of solar cell parameters - short circuit current, open circuit voltage, fill factor, efficiency. Optical losses, electrical losses, surface recombination velocity, quantum efficiency - external and internal, I-V characteristics of Solar cells. Fabrication and design of Solar cells. Performance enhance: Enhance absorption, Reduce series resistance, surface recombination.

Advanced Solar cell technologies (III Generation): Alternatives to conventional Si based solar cells - Thin film solar cells, Hetero junction solar cells, Tandem solar cells: material properties, fabrication and stability (includes nano scale devices). Organic solar cells.

TEXTBOOK:

Wenham S R, "Applied Photovoltaics", 2nd ed., Earthscan Publications Ltd., (2007).

REFERENCES:

1. *Peter Wurfel, "Physics of Solar Cells", 2nd Ed., Wiley VCH (2005).*
2. *S O Kasap, "Principles of Electronic Materials and Devices", McGraw-Hill, New York (2005).*

15PHY248 PHYSICS OF LASERS AND APPLICATIONS 3 0 0 3

Unit 1

Review of some basic concepts and principle of laser.

Introduction to light and its properties: Reflection, refraction, interference, diffraction and polarization. Photometry – calculation of solid angle. Brewster's law. Snell's law and, its analysis.

Introduction to LASERS: Interaction of radiation with matter - induced absorption, spontaneous emission, stimulated emission. Einstein's co-efficient (derivation). Active material. Population inversion – concept and discussion about different techniques. Resonant cavity.

Unit 2

Properties of LASERS

Gain mechanism, threshold condition for PI (derivation), emission broadening - line width, derivation of $\Delta\omega$ FWHM natural emission line width as deduced by quantum mechanics - additional broadening process: collision broadening, broadening due to dephasing collision, amorphous crystal broadening, Doppler broadening in laser and broadening in gases due to isotope shifts. Saturation intensity of laser, condition to attain saturation intensity.

Properties – coherency, intensity, directionality, monochromaticity and focussibility. LASER transition – role of electrons in LASER transition, levels of LASER action: 2 level, 3 level and 4 level laser system.

Unit 3

Types of LASERS

Solid state LASER: (i) Ruby LASER – principle, construction, working and application. (ii) Neodymium (Nd) LASERS. gas LASER: (i) He-Ne LASER - principle, construction, working and application. (i) CO2 LASER - principle, construction, working and application.

Liquid chemical and dye LASERS. Semiconductor LASER: Principle, characteristics, semiconductor diode LASERS, homo-junction and hetero-junction LASERS, high power semi conductor diode LASERS.

Applications in Communication field:

LASER communications: Principle, construction, types, modes of propagation, degradation of signal, analogue communication system, digital transmission, fiber optic communication.

Applications of LASERS in other fields:

Holography: Principle, types, intensity distribution, applications. laser induced fusion. Harmonic generation. LASER spectroscopy. LASERS in industry: Drilling, cutting and welding. Lasers in medicine: Dermatology, cardiology, dentistry and ophthalmology.

REFERENCES:

1. *William T Silfvast, "Laser Fundamentals", Cambridge University Press, UK (2003).*
2. *B B Laud, "Lasers and Non linear Optics", New Age International (P) Ltd., New Delhi.*
3. *Andrews, "An Introduction to Laser Spectroscopy (2e)", Ane Books India (Distributors).*
4. *K R Nambiar, "Lasers: Principles, Types and Applications", New Age International (P) Ltd., New Delhi.*
5. *T Suhara, "Semiconductor Laser Fundamentals", Marcel Dekker (2004).*

15PHY250 QUANTUM PHYSICS AND APPLICATIONS 3 0 0 3

Unit 1

Review of Planck's relation, De-Broglie relation and uncertainty principle basic concepts - Schrodinger equation: probabilistic interpretation of wave function, one dimension problems – particle in a box, harmonic oscillator, potential barrier and tunneling. Hydrogen atom, electrons in a magnetic field - X-ray spectra - periodic table.

Unit 2

Bosons and Fermions - symmetric and antisymmetric wavefunctions - elements of statistical physics: density of states, fermi energy, Bose condensation - solid state physics: Free electron model of metals, elementary discussion of band theory and applications to semiconductor devices.

Einstein coefficients and light amplification - stimulated emission - optical pumping and laser action.

Unit 3

Operation of He-Ne laser and Ruby laser - laser in science and Industry - Raman effect and applications.

Nuclear physics: nuclear properties - binding energy and mass formula - nuclear decay with applications - theory of alpha decay - nuclear forces – fission - principle of nuclear reactor - elementary particles - leptons, hadrons, quarks, field bosons - the standard model of elementary particles.

TEXTBOOK:

A Beiser, Perspectives in Modern Physics, McGraw Hill

REFERENCES;

1. *Arthur Beiser, Concepts of Modern Physics, 6th Edition Tata McGraw Hill*
2. *S H Patil, Elements of Modern Physics, Tata McGraw Hill, 1989*
3. *K Krane, Modern Physics, John Wiley, 1998.*
4. *K Thyagarajan, A K Ghatak, Lasers-Theory and Applications, Macmillan, 1991*

15PHY251 THIN FILM PHYSICS 3 0 0 3

Unit 1

Introduction and preparation of thin film: Difference between thin and thick film. Appreciation of thin film technology in modern era. Deposition technology: Physical methods, chemical methods, other new techniques, vacuum technology: Vacuum pumps & pressure gauges.

Defects in thin film: General concepts, nature of defect, microscopic defect and dislocation. Boundary defects. Defect and energy states - donar acceptor levels, trap and recombination centers, excitons, phonons.

Unit 2

Thin film analysis: Structural studies: XRD and electron diffraction. Surface studies: electron microscopy studies on film (SEM, TEM, AFM) Film composition: X-ray photoelectron spectroscopy (XPS), Rutherford Back Scattering spectroscopy (RBS) and Secondary Ion Mass Spectroscopy (SIMS).

Properties of thin film: Optical behaviors: transmission, reflection, refractive index, photoconductivity, and photoluminescence.

Unit 3

Electrical behaviors: sheet resistivity, electron mobility and concentration, Hall effect, conduction in MIS structure.

Mechanical behaviors: stress, adhesion, hardness, stiffness.

Applications of thin films in various fields: Antireflection coating, FET, TFT, resistor, thermistor, capacitor, solar cell, and MEMs fabrication of silicon wafer: Introduction. preparation of the silicon wafer media, silicon wafer processing steps.

TEXTBOOK:

K. L. Chopra, "Thin Film Phenomena", McGraw Hill, New York, 1969

REFERENCES:

1. *L. T. Meissel and R. Glang, "Hand book of thin film technology", McGraw Hill, 1978.*
1. *A. Goswami, "Thin Film Fundamentals", New Age International, Pvt Ltd, New Delhi, 1996.*
2. *O. S. Heavens "optical Properties of Thin Films" by, Dover Publications, Newyork 1991.*
3. *Milton Ohring "Materials science of thin films deposition and structures", Academic press, 2006.*
4. *Donald L. Smith "Thin Film deposition principle and Practice", McGraw Hill international Edition, 1995.*

15PHY331 ASTRONOMY 3 0 0 3

Unit 1

Astronomy, an Observational Science: Introduction - Indian and Western Astronomy – Aryabhatta - Tycho Brahe's observations of the heavens - The laws of planetary motion - Measuring the astronomical unit - Isaac Newton and his Universal Law of Gravity - Derivation of Kepler's third law - The Sun - The formation of the solar system- Overall properties of the Sun - The Sun's total energy output - Black body radiation and the sun's surface temperature - The Fraunhofer lines in the solar spectrum and the composition of the sun - Nuclear fusion - The proton–proton cycle - The solar neutrino problem - The solar atmosphere: photosphere, chromosphere and corona - Coronium - The solar wind- The sunspot cycle - Solar The Planets - Planetary orbits - Orbital inclination - Secondary atmospheres - The evolution of the earth's atmosphere.

Unit 2

Observational Astronomy

Observing the Universe - The classic Newtonian telescope - The Cassegrain telescope - Catadioptric telescopes - The Schmidt camera - The Schmidt–Cassegrain telescope - The Maksutov–Cassegrain telescope - Active and adaptive optics - Some significant optical telescopes - Gemini North and South telescopes - The Keck telescopes - The South Africa Large Telescope (SALT) - The Very Large Telescope (VLT) - The Hubble Space Telescope (HST) - The future of optical astronomy - Radio telescopes - The feed and low noise amplifier system - Radio receivers - Telescope designs - Large fixed dishes - Telescope arrays - Very Long Baseline Interferometry (VLBI) - The future of radio astronomy - Observing in other wavebands – Infrared – Sub-millimetre wavelengths - The Spitzer space telescope - Ultraviolet, X-ray and gamma-ray observatories - Observing the universe without using electromagnetic radiation - Cosmic rays - Gravitational waves.

Unit 3

The Properties of Stars: Stellar luminosity - Stellar distances - The hydrogen spectrum - Spectral types - Spectroscopic parallax - The Hertzsprung–Russell Diagram - The main sequence - The giant region - The white dwarf region - The stellar mass – luminosity relationship - Stellar lifetimes - Stellar Evolution – White dwarfs - The evolution of a sun-like star - Evolution in close binary systems – Neutron stars and black holes - The discovery of pulsars - Black holes: The Milky Way - Open star clusters - Globular clusters - Size, shape and structure of the Milky Way – observations of the hydrogen line - Other galaxies - Elliptical galaxies - Spiral galaxies - The Hubble classification of galaxies - The universe - The Cepheid variable distance scale - Starburst galaxies - Active galaxies - Groups and clusters of galaxies – Superclusters - The structure of the universe - Cosmology – the Origin and Evolution of the Universe - The expansion of the

universe - The cosmic microwave background - The hidden universe: dark matter and dark energy - The Drake equation - The Search for Extra Terrestrial Intelligence (SETI) - The future of the universe.

TEXTBOOK:

Introduction to Astronomy and Cosmology, Ian Morison, Wiley (UK), 2008

REFERENCE BOOK:

Astronomy: Principles and Practice, 4th Edition (Paperback), D. C. Clarke, A. E. RoyInstitute of Physics Publishing

15PHY333 CONCEPTS OF NANOPHYSICS AND NANOTECHNOLOGY 3 0 0 3

Unit 1

Introduction

Introduction to nanotechnology, comparison of bulk and nanomaterials – change in band gap and large surface to volume ratio, classification of nanostructured materials. Synthesis of nanomaterials - classification of fabrication methods – top down and bottom up methods.

Concept of quantum confinement and phonon confinement

Basic concepts – excitons, effective mass, free electron theory and its features, band structure of solids. Bulk to nanotransition – density of states, potential well - quantum confinement effect – weak and strong confinement regime. Electron confinement in infinitely deep square well, confinement in two and three dimension. Blue shift of band gap - effective mass approximation. Vibrational properties of solids - phonon confinement effect and presence of surface modes.

Unit 2

Tools for characterization:

Structural – X-ray diffraction, transmission electron microscope, scanning tunneling microscope, atomic force microscope. Optical - UV – visible absorption and photoluminescence techniques, Raman spectroscopy.

Nanoscale materials – properties and applications:

Carbon nanostructures – structure, electrical, vibration and mechanical properties. Applications of carbon nanotubes

Unit 3

Field emission and shielding – computers – fuel cells – chemical sensors – catalysis – mechanical reinforcement. Quantum dots and Magnetic nanomaterials – applications.

Nanoelectronics and nanodevices:

Impact of nanotechnology on conventional electronics. Nanoelectromechanical systems (NEMSs) – fabrication (lithography) and applications. Nanodevices - resonant tunneling diode, quantum cascade lasers, single electron transistors – operating principles and applications.

TEXTBOOKS:

1. *Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, Nanoscale Science and Technology, John Wiley and Sons Ltd 2004.*
2. *W. R. Fahrner (Ed.), Nanotechnology and Nanoelectronics, Springer 2006.*

15PHY335 MEDICAL PHYSICS 3 0 0 3

Unit 1

Ultrasonics - production methods and properties - acoustic impedance - Doppler velocimetry - echo cardiography – resolution – speckle - ultrasound imaging - therapeutic use of ultrasound - use in diagnostics of cardiac problems.

X-rays – production – intensity - hard and soft X-rays - characteristic and continuous X-ray spectrum - attenuation of x-rays by hard and soft tissues – resolution – contrast X-ray imaging - fluoroscopy modes of operation - image quality - fluoroscopy suites - radiation dose – computed-aided tomography (CAT).

Unit 2

Nuclear medicine - principles of nuclear physics – natural radioactivity, decay series, type of radiation and their applications, artificially produced isotopes and its application, accelerator principles; Nuclear Isomerism, internal conversion - ideal energy for radiotherapy based on interactions. Radionuclide used in medicine - radioisotope production – dosimetry – safety - radiation hazards – PET.

Nuclear magnetic resonance physics - magnetic moment – magnetization – relaxation - nuclear magnetic resonance spectroscopy.

Unit 3

Nuclear magnetic resonance imaging (MRI) – principle - chemical shift - magnetic resonance signal induction and relaxation - pulse sequencing and spatial encoding. Laser physics – characteristics of laser radiation, mode locking - power of laser radiation - lasers as diagnostic tool - lasers in surgery - laser speckle, biological effects, laser safety management.

TEXTBOOK:

Hendee W R and Rittenour E E, "Medical Imaging Physics", John Wiley & Sons, Chicago, 2001.

REFERENCE BOOKS

1. *Glasser. O. Medical Physics Vol.1, 2, 3 Book Publisher Inc Chicago, 1980*
2. *Jerraold T Bush Berg et al, The essentials physics of medical imaging, Lippincott Williams and Wilkins (2002)*

15PHY338 PHYSICS OF SEMICONDUCTOR DEVICES 3 0 0 3

Unit 1

Introduction: Unit cell, Bravais lattices, crystal systems, crystal planes and Miller indices, symmetry elements. Defects and imperfections – point defects, line defects, surface defects and volume defects.

Electrical conductivity: Classical free electron theory – assumptions, drift velocity, mobility and conductivity, drawbacks. quantum free electron theory – Fermi energy, Fermi factor, carrier concentration. Band theory of solids – origin of energy bands, effective mass, distinction between metals, insulators and semiconductors.

Unit 2

Theory of semiconductors: Intrinsic and extrinsic semiconductors, band structure of semiconductors, carrier concentration in intrinsic and extrinsic semiconductors, electrical conductivity and conduction mechanism in semiconductors, Fermi level in intrinsic and extrinsic semiconductors and its dependence on temperature and carrier concentration. Carrier generation - recombination, mobility, drift-diffusion current. Hall effect.

Theory of p-n junctions – diode and transistor: p-n junction under thermal equilibrium, forward bias, reverse bias, carrier density, current, electric field, barrier potential. V-I characteristics, junction capacitance and voltage breakdown.

Unit 3

Bipolar junction transistor, p-n-p and n-p-n transistors: principle and modes of operation, current relations. V-I characteristics. Fundamentals of MOSFET, JFET. Heterojunctions – quantum wells.

Semiconducting devices: Optical devices: optical absorption in a semiconductor, e--hole generation. Solar cells – p-n junction, conversion efficiency, heterojunction solar cells. Photo detectors – photo conductors, photodiode, p-i-n diode. Light emitting diode (LED) – generation of light, internal and external quantum efficiency.

Modern semiconducting devices: CCD - introduction to nano devices, fundamentals of tunneling devices, design considerations, physics of tunneling devices.

TEXTBOOKS:

1. *C Kittel, "Introduction to Solid State Physics", Wiley, 7th Edn., 1995.*
2. *D A Neamen, "Semiconductor Physics and Devices", TMH, 3rd Edn., 2007.*

REFERENCES:

1. *S M Sze, "Physics of Semiconductor Devices", Wiley, 1996.*
2. *P Bhattacharya, "Semiconductor Opto- Electronic Devices", Prentice Hall, 1996.*
3. *M K Achuthan & K N Bhat, "Fundamentals of Semiconductor Devices", TMH, 2007.*
4. *J Allison, "Electronic Engineering Materials and Devices", TMH, 1990.*

15PHY532 ASTROPHYSICS 3 0 0 3

Unit 1

Historical introduction: Old Indian and western – astronomy - Aryabhatta, Tycho Brahe, Copernicus, Galileo - Olbers paradox - solar system – satellites, planets, comets, meteorites, asteroids.

Practical astronomy - telescopes and observations & techniques – constellations, celestial coordinates, ephemeris.

Celestial mechanics - Kepler's laws - and derivations from Newton's laws.

Sun: Structure and various layers, sunspots, flares, faculae, granules, limb darkening, solar wind and climate.

Unit 2

Stellar astronomy: H-R diagram, color-magnitude diagram - main sequence - stellar evolution – red giants, white dwarfs, neutron stars, black holes - accretion disc - Schwartzchild radius - stellar masses Saha–Boltzman equation - derivation and interpretation.

Variable stars: Cepheid, RR Lyrae and Mira type variables - Novae and Super novae. Binary and multiple star system - measurement of relative masses and velocities. Interstellar clouds - Nebulae.

Unit 3

Galactic astronomy: Distance measurement - red shifts and Hubble's law – age of the universe, galaxies – morphology - Hubble's classification - gravitational lens, active galactic nuclei (AGNs), pulsars, quasars.

Relativity: Special theory of relativity - super-luminal velocity - Minkowski space - introduction to general theory of relativity – space - time metric, geodesics, space-time curvature. Advance of perihelion of Mercury, gravitational lens.

Cosmology: Comic principles, big bang and big crunch – cosmic background radiation - Nucleo-synthesis - plank length and time, different cosmic models - inflationary, steady state. Variation of G. anthropic principle.

REFERENCES:

1. *"Textbook of Astronomy and Astrophysics with elements of Cosmology", V. B. Bhatia, Narosa publishing 2001.*
2. *William Marshall Smart, Robin Michael Green "On Spherical Astronomy", (Editor) Carroll, Bradley W Cambridge University Press ,1977*

15PHY535 EARTH'S ATMOSPHERE 3 0 0 3

Unit 1

Earth's atmosphere: overview and vertical structure. Warming the earth and the atmosphere: temperature and heat transfer; absorption, emission, and equilibrium; incoming solar energy. Air temperature: daily variations, controls, data, human comfort, measurement. Humidity, condensation, and clouds: circulation of water in the atmosphere; evaporation, condensation, and saturation; dew and frost; fog.

Unit 2

Cloud development and precipitation: atmospheric stability & determining stability, cloud development and stability, precipitation processes, collision and coalescence, precipitation types, measuring precipitation. Air pressure and winds: atmospheric pressure, pressure measurement, surface and upper-air charts, surface winds, winds and vertical air motions, measuring and determining winds. Atmospheric circulations: scales of atmospheric motion, eddies, local wind systems, global winds, global wind patterns and the oceans.

Unit 3

Air masses, fronts, and mid-latitude cyclones. Weather forecasting: acquisition of weather information, forecasting methods and tools, forecasting using surface charts. Thunderstorms: ordinary (air-mass) thunderstorms, mesoscale convective complexes, floods and flash floods, distribution of thunderstorms, lightning and thunder. Tornadoes: severe weather and Doppler radar, waterspouts.

Unit 4

Hurricanes (cyclones, typhoons): tropical weather; anatomy, formation, dissipation and naming of hurricanes. Air pollution: a brief history, types and sources, factors that affect air pollution, the urban environment, acid deposition. Global climate: climatic classification; global pattern of climate.

Unit 5

Climate change: possible causes; carbon dioxide, the greenhouse effect, and

recent global warming. Light, colour, and atmospheric optics: white and colours, white clouds and scattered light; blue skies and hazy days, red suns and blue moons; twinkling, twilight, and the green flash; the mirage; halos, sundogs, and sun pillars; rainbows; coronas and cloud iridescence.

TEXTBOOK:

C. Donald Ahrens: Essentials of Meteorology: An Invitation to the Atmosphere (6th edition), Brooks-Cole, 2010.

REFERENCE:

Frederick K. Lutgens & Edward J. Tarbuck: The Atmosphere, An Introduction to Meteorology (11th Edition), Prentice Hall, 19 January, 2009

15PHY536 EARTH'S STRUCTURE AND EVOLUTION 3 0 0 3

Unit 1

Introduction: geologic time; earth as a system, the rock cycle, early evolution, internal structure & face of earth, dynamic earth. Matter and minerals: atoms, isotopes and radioactive decay; physical properties & groups of minerals; silicates, important nonsilicate minerals, resources. Igneous rocks: magma, igneous processes, compositions & textures; naming igneous rocks; origin and evolution of magma, intrusive igneous activity, mineral resources and igneous processes.

Unit 2

Volcanoes and volcanic hazards: materials extruded, structures and eruptive styles, composite cones and other volcanic landforms, plate tectonics and volcanic activity. Weathering and soils: earth's external processes; mechanical & chemical weathering, rates; soils, controls of formation, profile, classification, human impact, erosion, weathering and ore deposits. Sedimentary rocks: the importance and origins of sedimentary rocks; detrital & chemical sedimentary rocks, coal, converting sediment into sedimentary rock; classification & structures, nonmetallic mineral & energy resources. Metamorphism and metamorphic rocks: metamorphic textures, common metamorphic rocks, metamorphic environments & zones.

Unit 3

Mass wasting: gravity, mass-wasting and landform development, controls and triggers, classification of mass-wasting processes, slump, rockslide, debris flow, earthflow, slow movements. Running water: hydrologic cycle, running water, streamflow, work of running water, stream channels, base level and graded streams, shaping stream valleys, depositional landforms, drainage patterns, floods and flood control. Groundwater: importance and distribution, water table, factors influencing storage and movement, springs, wells, artesian wells, environmental problems, hot springs and geysers, geothermal energy, geologic work. Glaciers and glaciation: formation and movement, erosion & landforms, deposits, other

effects, causes. Deserts and wind: distribution and causes, geologic processes, basin and range, wind transport, erosion & deposits.

Unit 4

Shorelines: coastal zone, waves & erosion, sand movement, shoreline features & stabilization; erosion problems along U.S. coasts, hurricanes, coastal classification, tides. Earthquakes and earth's interior: faults, seismology, locating the source of an earthquake, measuring intensity, belts and plate boundaries, destruction, damage east of the Rocky Mountains, earthquake prediction, earth's interior. Plate tectonics: continental drift, divergent boundaries, convergent boundaries, transform fault boundaries, testing the plate tectonics model, the breakup of Pangaea, measuring plate motion, what drives plate motions, plate tectonics in the future.

Unit 5

Origin and evolution of the ocean floor: continental margins, features of deep-ocean basins, anatomy of oceanic ridge, oceanic ridges and seafloor spreading, nature of oceanic crust, continental rifting, destruction of oceanic lithosphere. Crustal deformation and mountain building: structures formed by ductile & brittle deformation, mountain building at subduction zones, collisional mountain belts, fault-block mountains, vertical movements of the crust. Geologic time: time scales, relative dating, correlation of rock layers; dating with radioactivity, the geologic time scale, difficulties in dating. Earth's evolution: birth of a planet, origin of the atmosphere and oceans, Precambrian (formation of continents); Phanerozoic (formation of modern continents & earth's first life); Paleozoic (life explodes); the Mesozoic (dinosaurs); Cenozoic era (mammals). Global climate change: climate & geology, climate system, detecting change; atmospheric basics & heating the atmosphere; natural & human causes; carbon dioxide, trace gases, and climate change; climate-feedback mechanisms, aerosols, some possible consequences.

TEXTBOOK:

Frederick K. Lutgens, Edward J. Tarbuck &Dennis G. Tasa: Essentials of Geology (11th edition), Prentice Hall, 8 March, 2012.

REFERENCE:

Graham R. Thompson & Jonathan Turk: Introduction to Physical Geology (2nd Edition), Brooks Cole, 23 June, 1997.

15PHY540 NONLINEAR DYNAMICS 3 0 0 3

Unit 1

Introduction: examples of dynamical systems, driven damped pendulum, ball on oscillating floor, dripping faucet, chaotic electrical circuits.

One-dimensional maps: the logistic map, bifurcations in the logistic map, fixed points and their stability, other one-dimensional maps.

Non-chaotic multidimensional flows: the logistic differential equation, driven damped harmonic oscillator, Van der Pol equation, numerical solution of differential equations.

Dynamical systems theory: two-dimensional equilibrium and their stability, saddle points, are contraction and expansion, non-chaotic three-dimensional attractors, stability of two-dimensional maps, chaotic dissipative flows.

Unit 2

Lyapunov exponents: for one- and two-dimensional maps and flows, for three-dimensional flows, numerical calculation of largest Lyapunov exponent, Lyapunov exponent spectrum and general characteristics, Kaplan-Yorke dimension, numerical precautions.

Strange attractors: general properties, examples, search methods, probability of chaos and statistical properties of chaos, visualization methods, basins of attraction, structural stability.

Bifurcations: in one-dimensional maps and flows, Hopf bifurcations, homoclinic and heteroclinic bifurcations, crises.

Hamiltonian chaos: Hamilton's equations and properties of Hamiltonian systems, examples, three-dimensional conservative flows, symplectic maps.

Unit 3

Time-series properties: examples, conventional linear methods, a case study, time-delay embeddings.

Nonlinear prediction and noise-reduction: linear predictors, state-space prediction, noise reduction, Lyapunov exponents from experimental data, false nearest neighbours. Fractals: Cantor sets, curves, trees, gaskets, sponges, landscapes.

Calculations of fractal dimension: similarity, capacity and correlation dimensions, entropy, BDS statistic, minimum mutual information, practical considerations.

Fractal measure and multifractals: convergence of the correlation dimension, multifractals, examples and numerical calculation of generalized dimensions.

Non-chaotic fractal sets: affine transformations, iterated functions systems, Mandelbrot and Julia sets.

Spatiotemporal chaos and complexity: examples, cellular automata, coupled map lattices, self-organized criticality.

TEXTBOOK:

Hilborn, R. C., Chaos and Nonlinear Dynamics, Second Edition, Oxford University Press, 2000

REFERENCES:

1. *Sprott, J. C., Chaos and Time Series Analysis, Oxford University Press, 2003*
2. *Strogatz, S. H., Nonlinear Dynamics and Chaos, Westview Press, 2001*
3. *Solari, H. G., Natiello, M. A., and Mindlin, G. B., Nonlinear Dynamics, Overseas Press (India) Private Limited, 2005*

15PHY542 OPTOELECTRONIC DEVICES 3 0 0 3

Unit 1

Properties of semiconductors: Electron and photon distribution: density of states, effective mass and band structure, effect of temperature and pressure on band gap, recombination processes.

Basics of semiconductor optics: Dual nature of light, band structure of various semiconductors, light absorption and emission, photoluminescence. electroluminescence, radioactive and non-radiative recombination, wave trains.

Unit 2

Semiconductor light-emitting diodes: Structure and types of LEDs and their characteristics, guided waves and optical modes, optical gain, confinement factor, internal and external efficiency, semiconductor heterojunctions, double-heterostructure LEDs.

Semiconductor lasers: Spontaneous and stimulated emission, principles of a laser diode, threshold current, effect of temperature, design of an edge-emitting diode, emission spectrum of a laser diode, quantum wells, quantum-well laser diodes.

Unit 3

Semiconductor light modulators: Modulating light (direct modulation of laser diodes, electro-optic modulation, acousto-optic modulation), isolating light (magneto-optic isolators), inducing optical nonlinearity (frequency conversion, switching)

Semiconductor light detectors: I-V characteristics of a p-n diode under illumination, photovoltaic and photoconductive modes, load line, photocells and photodiodes, p-i-n photodiodes, responsivity, noise and sensitivity, photodiode materials, electric circuits with photodiodes, solar cells.

REFERENCES:

1. *Semiconductor Optoelectronics: Physics and Technology, Jasprit Singh, McGraw Hill Companies, ISBN 0070576378*
2. *Optoelectronics, E. Rosencher and B. Vinter, Cambridge Univ. Press, ISBN 052177813.*
3. *Photonic Devices, J. Liu, Cambridge Univ. Press, ISBN 0521551951.*
4. *Semiconductor Optoelectronic Devices 2nd Edition", P. Bhattacharya, Prentice Hall, ISBN 0134956567.*
5. *Physics of Semiconductor Devices, by S. M. Size (2nd Edition, Wiley, New York, 1981).*

15SAN101 SANSKRIT I 1 0 2 2

OBJECTIVES: *To familiarize students with Sanskrit language and literature; to enable them to read and understand Sanskrit verses and sentences; to help them acquire expertise for self-study of Sanskrit texts and communication in Sanskrit; to help the students imbibe values of life and Indian culture as propounded in scriptures.*

Unit 1

Introduction to Sanskrit language, Devanagari script - Vowels and consonants, pronunciation, classification of consonants, conjunct consonants, words – nouns and verbs, cases – introduction, numbers, Pronouns, communicating time in Sanskrit. Practical classes in spoken Sanskrit

Unit 2

Verbs- Singular, Dual and plural – First person, Second person, Third person.

Tenses – Past, Present and Future – Atmanepadi and Parasmaipadi-kartharipraYoga

Unit 3

Words for communication, slokas, moral stories, subhashithas, riddles (from the books prescribed)

Unit 4

Selected slokas from Valmiki Ramayana, Kalidasa's works and Bhagavad Gita. Ramayana – chapter VIII - verse 5, Mahabharata - chapter 174, verse -16, Bhagavad Gita – chapter - IV verse 8, Kalidasa's Sakuntalam Act IV – verse 4

Unit 5

Translation of simple sentences from Sanskrit to English and vice versa.

ESSENTIAL READING:

1. *Praveshaha; Publisher: Samskrita bharati, Aksharam, 8th cross, 2nd phase, girinagar, Bangalore - 560 085*
2. *Sanskrit Reader I, II and III, R. S. Vadhyar and Sons, Kalpathi, Palakkad*

3. *Prakriya Bhashyam written and published by Fr. John Kunnappally*
4. *Sanskrit Primer by Edward Delavan Perry, published by Ginn and Company Boston*
5, *Sabdamanjari, R. S. Vadyar and Sons, Kalpathi, Palakkad*
6. *Namalinganusasanam by Amarasimha published by Travancore Sanskrit series*
7. *Subhashita Ratna Bhandakara by Kashinath Sharma, published by Nirnayasagar press*

15SAN111 SANSKRIT II 1 0 2 2

OBJECTIVES: *To familiarize students with Sanskrit language and literature; to enable them to read and understand Sanskrit verses and sentences; to help them acquire expertise for self-study of Sanskrit texts and communication in Sanskrit; to help the students imbibe values of life and Indian culture as propounded in scriptures.*

Unit 1
Seven cases, indeclinables, sentence making with indeclinables, Saptha karakas.

Unit 2
Ktavatu Pratyaya, Upasargas, Ktvanta, Tumunnanta, Lyabanta.
Three Lakaras – brief introduction, Lot lakara.

Unit 3
Words and sentences for advanced communication. Slokas, moral stories (Pancatantra) Subhashitas, riddles.

Unit 4
Introduction to classical literature, classification of Kavyas, classification of Dramas - The five Mahakavyas, selected slokas from devotional kavyas - Bhagavad Gita – chapter - II verse 47, chapter - IV verse 7, chapter - VI verse 5, chapter - VIII verse 6, chapter - XVI verse 21, Kalidasa's Sakuntala act IV – verse 4, Isavasyopanishat 1st Mantra, Mahabharata chapter 149 verses 14 - 120, Neetisara chapter - III

Unit 5
Translation of paragraphs from Sanskrit to English and vice versa.

ESSENTIAL READING:

1. *Praveshaha; Publisher: Samskrita bharati, Aksharam, 8th cross, 2nd phase, girinagar, Bangalore -560 085*
2. *Sanskrit Reader I, II and III, R.S. Vadhyar and Sons, Kalpathi, Palakkad*
3. *Prakriya Bhashyam written and published by Fr. John Kunnappally*
4. *Sanskrit Primer by Edward Delavan Perry, published by Ginn and Company Boston*
5. *Sabdamanjari, R. S. Vadyar and Sons, Kalpathi, Palakkad*
6. *Namalinganusasanam by Amarasimha published by Travancore Sanskrit series*
7. *Subhashita Ratna Bhandakara by Kashinath Sharma, published by Nirnayasagar Press.*

15SSK221 SOFT SKILLS I 1 0 2 2

Soft skills and its importance: Pleasure and pains of transition from an academic environment to work-environment. Need for change. Fears, stress and competition in the professional world. Importance of positive attitude, self motivation and continuous knowledge upgradation.

Self-confidence: Characteristics of the person perceived, characteristics of the situation, characteristics of the perceiver. Attitude, values, motivation, emotion management, steps to like yourself, positive mental attitude, assertiveness.

Presentations: Preparations, outlining, hints for efficient practice, last minute tasks, means of effective presentation, language, gestures, posture, facial expressions, professional attire.

Vocabulary building: A brief introduction into the methods and practices of learning vocabulary. Learning how to face questions on antonyms, synonyms, spelling error, analogy, etc. Faulty comparison, wrong form of words and confused words like understanding the nuances of spelling changes and wrong use of words. Listening skills: The importance of listening in communication and how to listen actively.

Prepositions, articles and punctuation: A experiential method of learning the uses of articles and prepositions in sentences is provided.

Problem solving level I: Number system; LCM &HCF; Divisibility test; Surds and indices; Logarithms; Ratio, proportions and variations; Partnership;
Problem solving level II: Time speed and distance; work time problems;

Data interpretation: Numerical data tables; Line graphs; Bar charts and Pie charts; Caselet forms; Mix diagrams; Geometrical diagrams and other forms of data representation.

Logical reasoning: Family tree; Deductions; Logical connectives; Binary logic; Linear arrangements; Circular and complex arrangement; Conditionalities and grouping; Sequencing and scheduling; Selections; Networks; Codes; Cubes; Venn diagram in logical reasoning; Quant based reasoning; Flaw detection; Puzzles; Cryptogrithms.

TEXTBOOKS:

1. *A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.*
2. *Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.*
3. *Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.*
4. *The Hard Truth about Soft Skills, by Amazone Publication.*

5. *Quantitative Aptitude by R. S. Aggarwal, S. Chand*
6. *Quantitative Aptitude – Abijith Guha, TMH.*
7. *Quantitative Aptitude for Cat - Arun Sharma. TMH.*

REFERENCES:

1. *Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.*
2. *More Games Teams Play, by Leslie Bendaly, McGraw Hill Ryerson.*
3. *The BBC and British Council online resources*
4. *Owl Purdue University online teaching resources*

www.the grammarbook.com - online teaching resources

www.englishpage.com- online teaching resources and other useful websites.

15SSK321 SOFT SKILLS II 1 0 2 2

Professional grooming and practices: Basics of corporate culture, key pillars of business etiquette. Basics of etiquette: Etiquette – socially acceptable ways of behaviour, personal hygiene, professional attire, cultural adaptability. Introductions and greetings: Rules of the handshake, earning respect, business manners. Telephone etiquette: activities during the conversation, conclude the call, to take a message. Body Language: Components, undesirable body language, desirable body language. Adapting to corporate life: Dealing with people.

Group discussions: Advantages of group discussions, structured GD – roles, negative roles to be avoided, personality traits to do well in a GD, initiation techniques, how to perform in a group discussion, summarization techniques.

Listening comprehension advanced: Exercise on improving listening skills, grammar basics: Topics like clauses, punctuation, capitalization, number agreement, pronouns, tenses etc.

Reading comprehension advanced: A course on how to approach middle level reading comprehension passages.

Problem solving level III: Money related problems; Mixtures; Symbol based problems; Clocks and calendars; Simple, linear, quadratic and polynomial equations; special equations; Inequalities; Functions and graphs; Sequence and series; Set theory; Permutations and combinations; Probability; Statistics.

Data sufficiency: Concepts and problem solving.

Non-verbal reasoning and simple engineering aptitude: Mirror image; Water image; Paper folding; Paper cutting; Grouping of figures; Figure formation and analysis; Completion of incomplete pattern; Figure matrix; Miscellaneous.

Spacial aptitude: Cloth, leather, 2D and 3D objects, coin, match sticks, stubs, chalk, chess board, land and geodesic problems etc., related problems.

TEXTBOOKS:

1. *A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.*
2. *Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.*
3. *Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.*
4. *The Hard Truth about Soft Skills, by Amazone Publication.*
5. *Quick Maths – Tyra.*
6. *Quicker Arithmetic – Ashish Aggarwal*
7. *Test of reasoning for competitive examinations by Thorpe.E. TMH*
8. *Non-verbal reasoning by R. S. Aggarwal, S. Chand*

REFERENCES:

1. *Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova*
2. *More Games Teams Play, by Leslie Bendaly, McGraw Hill Ryerson.*
3. *The BBC and British Council online resources*
4. *Owl Purdue University online teaching resources*

www.the grammarbook.com - online teaching resources

www.englishpage.com- online teaching resources and other useful websites.

15SSK331 SOFT SKILLS III 1 0 2 2

Team work: Value of team work in organisations, definition of a team, why team, elements of leadership, disadvantages of a team, stages of team formation. Group development activities: Orientation, internal problem solving, growth and productivity, evaluation and control. Effective team building: Basics of team building, teamwork parameters, roles, empowerment, communication, effective team working, team effectiveness criteria, common characteristics of effective teams, factors affecting team effectiveness, personal characteristics of members, team structure, team process, team outcomes.

Facing an interview: Foundation in core subject, industry orientation/knowledge about the company, professional personality, communication skills, activities before interview, upon entering interview room, during the interview and at the end. Mock interviews.

Advanced grammar: Topics like parallel construction, dangling modifiers, active and passive voices, etc.

Syllogisms, critical reasoning: A course on verbal reasoning. Listening comprehension advanced: An exercise on improving listening skills.

Reading comprehension advanced: A course on how to approach advanced level of reading, comprehension passages. Exercises on competitive exam questions.

Problem solving level IV: Geometry; Trigonometry; Heights and distances; Co-ordinate geometry; Mensuration.

Specific training: Solving campus recruitment papers, national level and state level competitive examination papers; Speed mathematics; Tackling aptitude problems asked in interview; Techniques to remember (In mathematics). Lateral thinking problems. Quick checking of answers techniques; Techniques on elimination of options, estimating and predicting correct answer; Time management in aptitude tests; Test taking strategies.

TEXTBOOKS:

1. *A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.*
2. *Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.*
3. *Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.*
4. *The Hard Truth about Soft Skills, by Amazone Publication.*
5. *Data Interpretation by R. S. Aggarwal, S. Chand*
6. *Logical Reasoning and Data Interpretation – Niskit K Sinkha*
7. *Puzzles – Shakuntala Devi*
8. *Puzzles – George J. Summers.*

REFERENCES:

1. *Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.*
2. *More Games Teams Play, by Leslie Bendaly, McGraw-Hill Ryerson.*
3. *The BBC and British Council online resources*
4. *Owl Purdue University online teaching resources*

www.the grammarbook.com - online teaching resources

www.englishpage.com- online teaching resources and other useful websites.

15SWK230 CORPORATE SOCIAL RESPONSIBILITY 2 0 0 2

Unit 1

Understanding CSR - Evolution, importance, relevance and justification. CSR in the Indian context, corporate strategy. CSR and Indian corporate. Structure of CSR - In the Companies Act 2013 (Section 135); Rules under Section 13; CSR activities, CSR committees, CSR policy, CSR expenditure CSR reporting.

Unit 2

CSR Practices & Policies - CSR practices in domestic and international area; Role and contributions of voluntary organizations to CSR initiatives. Policies; Preparation of CSR policy and process of policy formulation; Government expectations, roles

and responsibilities. Role of implementation agency in Section 135 of the Companies Act, 2013. Effective CSR implementation.

Unit 3

Project Management in CSR initiatives - Project and programme; Monitoring and evaluation of CSR Interventions. Reporting - CSR Documentation and report writing. Reporting framework, format and procedure.

REFERENCES:

1. *Corporate Governance, Ethics and Social Responsibility, V Bala Chandran and V Chandrasekaran, PHI learning Private Limited, New Delhi 2011.*
2. *White H. (2005) Challenges in evaluating development effectiveness: Working paper 242, Institute of Development Studies, Brighton.*
3. *UNDP (nd) Governance indicators: A users guide. Oslo: UNDP*
4. *Rao, Subbha (1996) Essentials of Human Resource Management and Industrial Relations, Mumbai, Himalaya*
5. *Rao, V. S. L. (2009) Human Resource Management, New Delhi, Excel Books,*

15SWK231 WORKPLACE MENTAL HEALTH 2 0 0 2

Unit 1

Mental Health – concepts, definition, Bio-psycho-social model of mental health. Mental health and mental illness, characteristics of a mentally healthy individual, Signs and symptoms of mental health issues, presentation of a mentally ill person. Work place – definition, concept, prevalence of mental health issues in the work place, why invest in workplace mental health, relationship between mental health and productivity, organizational culture and mental health. Case Study, Activity.

Unit 2

Mental Health Issues in the Workplace: Emotions, Common emotions at the workplace, Mental Health issues - Anger, Anxiety, Stress & Burnout, Depression, Addictions – Substance and Behavioural, Psychotic Disorders - Schizophrenia, Bipolar Disorder, Personality disorders. Crisis Situations - Suicidal behavior, panic attacks, reactions to traumatic events. Stigma and exclusion of affected employees. Other issues –work-life balance, Presenteeism, Harassment, Bullying, Mobbing. Mental Health First Aid - Meaning. Case Study, Activity.

Unit 3

Strategies of Help and Care: Positive impact of work on health, Characteristics of mentally healthy workplace, Employee and employer obligations, Promoting mental health and well being- corporate social responsibility (CSR), an inclusive work environment, Training and awareness raising, managing performance, inclusive

recruitment, Supporting individuals-talking about mental health, making reasonable adjustments, Resources and support for employees - Employee Assistance Programme / Provider (EAP), in house counsellor, medical practitioners, online resources and telephone support, 24 hour crisis support, assistance for colleagues and care givers, Legislations. Case Study, Activity.

REFERENCES:

1. *American Psychiatric Association. "Diagnostic and statistical manual of mental disorders: DSM-IV 4th ed." www.terapiacognitiva.eu/dwl/dsm5/DSM-IV.pdf*
2. *American Psychiatric Association. (2000) www.ccsa.ca/Eng/KnowledgeCentre/OurDatabases/Glossary/Pages/index.aspx.*
3. *Canadian Mental Health Association, Ontario "Workplace mental health promotion, A how to guide"wmhp.cmhaontario.ca/*
4. *Alberta Health Services Mental Health Promotion. (2012). Minding the Workplace: Tips for employees and managers together. Calgary: Alberta Health Services.http://www.mentalhealthpromotion.net/resources/minding-the-workplace-tips-for-employees-and-managers-together.pdf*
5. *Government of Western Australia, Mental Health Commission. (2014) "Supporting good mental health in the work place." http://www.mentalhealth.wa.gov.au/Libraries/pdf_docs/supporting_good_mental_health_in_the_workplace_1.sflb.ashx*
6. *Mental Health Act 1987 (India) www.tnhealth.org/mha.htm*
7. *Persons with disabilities Act 1995 (India) socialjustice.nic.in*
8. *The Factories Act 1948 (India) www.caaa.in/Image/19ulabourlawshb.pdf*

15TAM101 TAMIL I 1 0 2 2

Objectivs : To introduce the students to different literature - Sangam literature, Epics, Bhakthi literature and modern literature. To improve their ability to communicate with creative concepts, and also to introduce them to the usefulness of basic grammatical components in Tamil.

Unit 1

Sangam literature : Kuṟuntokai; (2, 6,8,40 pāṭalkaḷ) – puṟanāṉūṟu (74,112,184,192 pāṭalkaḷ) – tiṟukkuṟaḷ (iṟaimāṭci, amaiccu)

Unit 2

Epic literature: cilappatikāram maturaik kāṇṭam (vaḻakkuṟaikkātai 50-55)
Spiritual Literature: tiruppāvai(3,4) – tēvāram (mācilvīṇaiyum)
Medieval Literature: bāratiyar kaṇṇaṉ pāṭṭu (eṉ viḷaiyāṭṭu piḷḷai) – bāratitacaṉ kuṭumpaviḷakku (tāyiṉ tālāṭṭu).

Unit 3

Novel: Jeyakāntaṉ "kuru pīṭam"
Essay: Aṇṇā "ē tāḻnta tamiḻakamē"

Unit4

Tiruñāṉa campantar – tirunāvukkaracar – cuntarar – māṇikka vācakar – āṇṭāḷ – tirumūlar – kulacēkara āḻvār – cīttalaic cāttaṉār toṭarpāṉa ccytikaḷ, mēṟkōḷkaḷ maṟṟum ciṟappup peyarkaḷ

Unit 5

Tamil Grammar: Col vakaikaḷ - vēṟṟumai urupukaḷ - valliṉam mikumiṭam mikāyiṭam - canti(puṇarcci) - ilakkaṇakkuṟippu.
Practical skills: Listening, speaking, writing and reading

Textbooks:

- *Aṇṇā "ē tāḻnta tamiḻakamē" nakkīraṉ papḷikēṣaṉs.*
- *Caktitācaṉ cupramaṇiyaṉ "nalla kuṟuntokai mūlamumuraiyum" mullai patippakam, 2008.*
- *http:/Www.Tamilvu.Org/libirary/libindex.IItm.*
- *jeyakāntaṉ "kuru pīṭam" mīṉāṭci puttaka nilaiyam, 1971.*
- *Nā.Pārttacārati "puṟanāṉūṟṟuc ciṟukataikaḷ" tamiḻp puttakālayam, 1978, 2001*
- *Poṉ maṇimāṟaṉ "aṭōṉ tamiḻ ilakkaṇam "aṭōṉ papḷiṣiṅ kurūp, vañciyūr, tiruvaṉantapuram, 2007.*
- *puliyūrk kēcikaṉ "kuṟuntokai mūlamum uraiyum" cārāta patippakam, 2010.*
- *Puliyūrk kēcikaṉ "puṟanāṉūṟu" srīceṇpakā patippakam, 2010*

15TAM111 TAMIL I I 1 0 2 2

Objectives: To learn the history of Tamil literature. To analyze different styles, language training, to strengthen the creativity in communication, Tamil basic grammar, Computer and its use in Tamil language.

Unit 1

The history of Tamil literature: Nāṭṭupuṟap pāṭalkaḷ, kataikkaḷ, paḻamoḻikaḷ - ciṟukataikaḷ tōṟṟamum vaḷarcciyum,
ciṟṟilakkiyaṅkaḷ: Kaliṅkattup paraṇi (pōrpāṭiyatu) - mukkūṭaṟ paḷḷu 35.

Aṟanūlkaḷ: Ulakanīti (1-5) – ēlāti (1,3,6). - Cittarkaḷ: Kaṭuveḷi cittar pāṭalkaḷ (āṉantak kaḷippu –1,4,6,7,8), maṟṟum akappēy cittar pāṭalkaḷ(1-5).

Unit 3

tamiḻ ilakkaṇam: Vākkiya vakaikaḷ – taṉviṉai piṟaviṉai – nērkkūṟṟu ayaṟkūṟṟu

Unit 4

tamiḻaka aṟiñarkaḷiṉ tamiḻ toṇṭum camutāya toṇṭum: Pāratiyār, pāratitācaṉ, paṭṭukkōṭṭai kalyāṇacuntaram, curatā, cujātā, ciṟpi, mēttā, aptul rakumāṉ, na.Piccaimūrtti, akilaṉ, kalki, jī.Yū.Pōp, vīramāmuṉivar, aṇṇā, paritimāṟ kalaiñar, maṟaimalaiyaṭikaḷ.

Unit 5

tamiḻ moḻi āyvil kaṇiṉi payaṉpāṭu. - Karuttu parimāṟṟam - viḷampara moḻiyamaippu – pēccu - nāṭakam paṭaippu - ciṟukatai, katai, putiṉam paṭaippu.

Textbooks:

- *http:/Www.tamilvu.trg/libirary/libindex.htm.*
- *http:/Www.tunathamizh.tom/2013/07/blog0post_24.html*
- *Mu.Varatarācaṉ "tamiḻ ilakkiya varalāṟu" cāhitya akaṭemi papḷikēṣaṉs, 2012*
- *nā.Vāṉamāmalai "paḻaṅkataikaḷum, paḻamoḻikaḷum" niyū ceñcuri puttaka veḷiyīṭṭakam, 1980,2008*
- *nā.Vāṉamāmalai, "tamiḻar nāṭṭuppāṭalkaḷ" niyū ceñcuri puttaka veḷiyīṭṭakam 1964,2006*
- *poṉ maṇimāṟaṉ "aṭōṉ tamiḻ ilakkaṇam "aṭōṉ papḷiṣiṅ kurūp, vañciyūr, tiruvaṉantapuram, 2007.*