AMRITA VISHWA VIDYAPEETHAM
DEEMED TO BE UNIVERSITY
School of Engineering

AMRITAPURI, BENGALURU, COIMBATORE, CHENNAI

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

B.Tech. in ELECTRICAL AND ELECTRONICS ENGINEERING

(BTC-EEE)

CURRICULUM AND SYLLABI
2019

GENERAL INFORMATION

ABBREVIATIONS USED IN THE CURRICULUM

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

AES	-	Aerospace Engineering
AIE	-	Computer Science and Engineering - Artificial Intelligence
BIO	-	Biology
CCE	-	Computer and Communication Engineering
CHE	-	Chemical Engineering
CHY	-	Chemistry
CSE	-	Computer Science and Engineering
CVL	-	Civil Engineering
CUL	-	Cultural Education
EAC	-	Electronics and Computer Engineering
ECE	-	Electronics and Communication Engineering
EEE	-	Electrical and Electronics Engineering
ELC	-	Electrical and Computer Engineering
HUM	-	Humanities
MAT	-	Mathematics
MEE	-	Mechanical Engineering
PHY	-	Physics

Course Outcome (CO) – Statements that describe what students are expected to know, and are able to do at the end of each course. These relate to the skills, knowledge and behaviour that students acquire in their progress through the course.

Program Outcomes (POs) – Program Outcomes are statements that describe what students are expected to know and be able to do upon graduating from the Program. These relate to the skills, knowledge, attitude and behaviour that students acquire through the program. NBA has defined the Program Outcomes for each discipline.

PROGRAM OUTCOMES FOR ENGINEERING

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

SEMESTER I

Cat.	Code	Title	L T P	Credit
HUM	19ENG111	Technical Communication	2 0 3	3
SCI	19MAT101	Single Variable Calculus	1 0 0	1
SCI	19MAT106	Ordinary Differential Equation	2 0 0	2
SCI	19MAT102	Matrix Algebra	2 0 0	2
ENGG	19CSE100	Problem Solving and Algorithmic Thinking	2 1 3	4
SCI	19PHY101/ 19CHY102	Engineering Physics - A/ Engineering Chemistry - B	2 1 0	3
SCI	19PHY181/ 19CHY182	Engineering Physics Lab - A / Engineering Chemistry Lab - B	0 0 3	1
ENGG	19MEE181	Manufacturing Practice	0 0 3	1
ENGG	19MEE100	Engineering Graphics - CAD	2 0 3	3
HUM	19CUL101	Cultural Education - I	2 0 0	2
		TOTAL	32	22

SEMESTER II

Cat.	Code	Title	L T P	Credit
HUM		Free Elective I**	2 0 0	2
SCI	19MAT111	Multivariable Calculus	2 0 0	2
SCI	19MAT116	Laplace Transform	1 0 0	1
SCI	19PHY101/ 19CHY102	Engineering Physics - A/ Engineering Chemistry - B	2 1 0	3
SCI	19PHY181/ 19CHY182	Engineering Physics Lab - A / Engineering Chemistry Lab - B	0 0 3	1
ENGG	19CSE102	Computer Programming	3 0 3	4
ENGG	19EEE113	Electrical Engineering Practice	1 0 3	2
ENGG	19EEE112	Electric Circuits	3 0 3	4
ENGG	19EEE114	Electronic Circuits	3 0 3	4
HUM	19CUL111	Cultural Education - II	2 0 0	2
		TOTAL	35	25

SEMESTER III

Cat.	Code	Title	L T P	Credit
SCI	19MAT214	Fourier Transforms and Complex Analysis	2 1 0	3
ENGG	19EEE205	Fundamentals of Mechanical Engineering	2 0 0	2
ENGG	19EEE206	Material Science for Electrical Engineering	2 0 0	2
ENGG	19EEE202	Analog Integrated Circuits	3 0 3	4
ENGG	19EEE204	Electrical Measurements	3 0 3	4
ENGG	19EEE203	Digital Systems	3 0 3	4
ENGG	19EEE201	Electromagnetic Theory	3 0 0	3
HUM	19AVP201	Amrita Values Programme I	1 0 0	1
		TOTAL	29	23

SEMESTER IV

Cat.	Code	Title	L T P	Credit
SCI	19MAT216	Probability and Statistics	2 1 0	3
ENGG	19EEE213	Electrical Machines I	3 0 3	4
ENGG	19EEE214	Signals and Systems	3 0 3	4
ENGG	19EEE212	Electrical Energy Systems I	3 0 3	4
ENGG	19EEE211	Control Systems	3 0 3	4
HUM		Free Elective II**	2 0 0	2
HUM	19SSK211	Soft Skills I	1 0 2	2
HUM	19AVP211	Amrita Value Programme II	1 0 0	1
		TOTAL	33	24

SEMESTER V

Cat.	Code	Title	L T P	Credit
ENGG	19EEE302	Electrical Energy Systems II	3 0 3	4
ENGG	19EEE304	Power Electronics	3 0 3	4
ENGG	19EEE301	Digital Signal Processing	3 0 3	4
ENGG	19EEE303	Electrical Machines II	3 0 3	4
ENGG		Professional Elective I*	3 0 0	3
ENGG		Professional Elective II*	3 0 0	3
HUM	19SSK301	Soft Skills II	1 0 2	2
ENGG	19LIV390	[Live in Labs]***		[3]
		TOTAL	33	24

SEMESTER VI

Cat.	Code	Title	L T P	Credit
ENGG	19EEE312	Electric Drives and Control	3 0 3	4
ENGG	19ELC212	Microcontrollers and Applications	3 0 3	4
ENGG		Professional Elective III*	3 0 0	3
ENGG		Professional Elective IV*	3 0 0	3
ENGG	19MAT213	Optimization Techniques	3 0 0	3
ENGG	19EEE313	Introduction to Python programming	1 0 0	1
ENGG	19EEE311	Software based Solutions for Electrical Engineering	0 0 3	1
ENGG	19EEE381	Open Lab	0 0 3	1
HUM	19SSK311	Soft Skills III	1 0 3	2
ENGG	19LIV490	[Live in Labs]***		[3]
HUM	19LAW300	Indian Constitution		P/F
		TOTAL	31	22+[3]

SEMESTER VII

Cat.	Code	Title	L T P	Credit
ENGG	19EEE401	Power System Protection and Switch Gear	3 0 3	4
ENGG		Professional Elective V*	3 0 0	3
ENGG		Professional Elective VI*	3 0 0	3
ENGG		Professional Elective VII*	3 0 0	3
HUM	19ENV300	Environmental Science		P/F
HUM	19MNG300	Disaster Management		P/F
ENGG	19EEE495	Project Phase I	0 0 6	2
		TOTAL	21	15

SEMESTER VIII

Cat.	Code	Title	L T P	Credit
ENGG	19EEE499	Project Phase II	0 0 30	10
		TOTAL	30	10

Total Credits	165

***Professional Elective -** Electives categorised under Engineering, Science ,Mathematics, Live-in-Labs, and NPTEL Courses . Student can opt for such electives across departments/campuses.Students with CGPA of 7.0 and above can opt for a maximum of 2 NPTEL courses with the credits not exceeding 8.

**** Free Electives -** This will include courses offered by Faculty of Humanities and Social Sciences/ Faculty Arts, Commerce and Media / Faculty of Management/Amrita Darshanam -(International Centre for Spiritual Studies).

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

PROFESSIONAL ELECTIVES				
POWER AND ENERGY SYSTEMS				
Cat.	**Code**	**Title**	**L T P**	**Credit**
ENGG	19EEE331	Smart Grid and IoT	3 0 0	3
ENGG	19EEE332	Deregulated Power Systems	3 0 0	3
ENGG	19EEE333	High Voltage Engineering	3 0 0	3
ENGG	19EEE334	Design of Electrical Apparatus	3 0 0	3
ENGG	19EEE335	Power Quality and FACTS	3 0 0	3
ENGG	19EEE336	Power Converters	3 0 0	3
ENGG	19EEE337	Power System Management	3 0 0	3
ENGG	19EEE338	Power plant Instrumentation	3 0 0	3
ENGG	19EEE339	Power system operation, control and stability	3 0 0	3
ENGG	19EEE340	Utilization of Electrical Energy	3 0 0	3
ENGG	19EEE341	Renewable Energy and Energy Conservation	3 0 0	3
ENGG	19EEE342	Design of Electrical Systems	3 0 0	3
ENGG	19EEE343	Management of Power Distribution	3 0 0	3
ENGG	19EEE344	Energy Storage Systems	3 0 0	3

EMBEDDED CONTROL & AUTOMATION				
Cat.	**Code**	**Title**	**L T P**	**Credit**
ENGG	19EEE351	Advanced Control Systems	3 0 0	3
ENGG	19EEE352	Digital Control System	3 0 0	3
ENGG	19EEE353	Process Control and Instrumentation	3 0 0	3
ENGG	19EEE354	Introduction to Robotics	3 0 0	3
ENGG	19EEE355	Mechatronics	3 0 0	3
ENGG	19EEE356	Industrial Electronics	3 0 0	3
ENGG	19EEE357	Embedded Systems Design	3 0 0	3
ENGG	19EEE358	Advanced Microcontrollers	3 0 0	3
ENGG	19EEE359	Digital Signal Processors	3 0 0	3
ENGG	19EEE360	VLSI System Design	3 0 0	3

AUTOMOTIVE SYSTEMS				
Cat.	**Code**	**Title**	**L T P**	**Credit**
ENGG	**19EEE431**	**Electric Vehicles**	**3 0 0**	**3**
ENGG	**19EEE432**	**Vehicular Networks and Communication**	**3 0 0**	**3**
ENGG	**19EEE433**	**E-mobility Business and Policies**	**3 0 0**	**3**
ENGG	**19EEE434**	**Automotive Electronics**	**3 0 0**	**3**
ENGG	**19EEE435**	**Automotive Control Systems**	**3 0 0**	**3**
ENGG	**19EEE436**	**Vehicle Dynamics and Control**	**3 0 0**	**3**

COMPUTER ENGINEERING				
Cat.	**Code**	**Title**	**L T P**	**Credit**
ENGG	**19CSE330**	**Information Technology Essentials**	**3 0 0**	**3**
ENGG	**19CSE331**	**Cryptography**	**3 0 0**	**3**
ENGG	**19CSE348**	**Machine Learning**	**3 0 0**	**3**
ENGG	**19CSE349**	**Virtual Reality**	**3 0 0**	**3**
ENGG	**19CSE350**	**Internet of Things**	**3 0 0**	**3**
ENGG	**19CSE362**	**Fundamentals of Soft Computing**	**3 0 0**	**3**
ENGG	**19CSE363**	**Artificial Intelligence**	**3 0 0**	**3**
ENGG	**19CSE364**	**Big Data Analytics**	**3 0 0**	**3**
ENGG	**19CSE365**	**Computer Organization and Design**	**3 0 0**	**3**
ENGG	**19CSE366**	**Cyber Security**	**3 0 0**	**3**
ENGG	**19CSE367**	**Digital Image Processing**	**3 0 0**	**3**
ENGG	**19CSE368**	**Introduction to Computer Networks**	**3 0 0**	**3**
ENGG	**19CSE369**	**Introduction to Data Structures and Algorithms**	**3 0 0**	**3**

GENERAL				
Cat.	**Code**	**Title**	**L T P**	**Credit**
ENGG	**19EEE441**	**Network Synthesis**	**3 0 0**	**3**
ENGG	**19EEE442**	**Opto-Electronics & Laser Instrumentation**	**3 0 0**	**3**
ENGG	**19EEE443**	**Special Electric Machines**	**3 0 0**	**3**
ENGG	**19EEE444**	**Electromagnetic Compatibility**	**3 0 0**	**3**
ENGG	**19EEE445**	**Illumination Engineering**	**3 0 0**	**3**
ENGG	**19EEE446**	**Communication Engineering**	**3 0 0**	**3**
ENGG	**19EEE447**	**Biomedical Systems**	**3 0 0**	**3**
ENGG	**19EEE448**	**Biological Control Systems**	**3 0 0**	**3**
ENGG	**19EEE449**	**3D Printing & Design**	**3 0 0**	**3**
ENGG	**19ECE331**	**Biomedical Instrumentation**	**3 0 0**	**3**
ENGG	**19MNG331**	**Financial Management**	**3 0 0**	**3**

PROFESSIONAL ELECTIVES UNDER SCIENCE STREAM

CHEMISTRY				
Cat.	**Code**	**Title**	**L T P**	**Credit**
SCI	**19CHY243**	**Computational Chemistry and Molecular Modelling**	**3 0 0**	**3**
SCI	**19CHY236**	**Electrochemical Energy Systems and Processes**	**3 0 0**	**3**
SCI	**19CHY240**	**Fuels and Combustion**	**3 0 0**	**3**
SCI	**19CHY232**	**Green Chemistry and Technology**	**3 0 0**	**3**
SCI	**19CHY239**	**Instrumental Methods of Analysis**	**3 0 0**	**3**
SCI	**19CHY241**	**Batteries and Fuel Cells**	**3 0 0**	**3**
SCI	**19CHY242**	**Corrosion Science**	**3 0 0**	**3**
PHYSICS				
SCI	**19PHY340**	**Advanced Classical Dynamics**	**3 0 0**	**3**
SCI	**19PHY342**	**Electrical Engineering Materials**	**3 0 0**	**3**
SCI	**19PHY331**	**Physics of Lasers and Applications**	**3 0 0**	**3**
SCI	**19PHY341**	**Concepts of Nanophysics and Nanotechnology**	**3 0 0**	**3**
SCI	**19PHY343**	**Physics of Semiconductor Devices**	**3 0 0**	**3**

SCI	**19PHY339**	**Astrophysics**	**3 0 0**	**3**
MATHEMATICS				
SCI	**19MAT341**	**Statistical Inference**	**3 0 0**	**3**
SCI	**19MAT342**	**Introduction to Game Theory**	**3 0 0**	**3**
SCI	**19MAT343**	**Numerical Methods and Optimization**	**3 0 0**	**3**

FREE ELECTIVES

FREE ELECTIVES OFFERED UNDER MANAGEMENT STREAM				
Cat.	**Code**	**Title**	**L T P**	**Credit**
HUM	**19MNG331**	**Financial Management**	**3 0 0**	**3**
HUM	**19MNG332**	**Supply Chain Management**	**3 0 0**	**3**
HUM	**19MNG333**	**Marketing Management**	**3 0 0**	**3**
HUM	**19MNG334**	**Project Management**	**3 0 0**	**3**
HUM	**19MNG335**	**Enterprise Management**	**3 0 0**	**3**
HUM	**19MNG338**	**Operations Research**	**3 0 0**	**3**
HUM	**19MEE401**	**Industrial Engineering**	**3 0 0**	**3**
HUM	**19MEE346**	**Managerial Statistics**	**3 0 0**	**3**
HUM	**19MEE347**	**Total Quality Management**	**3 0 0**	**3**
HUM	**19MEE342**	**Lean Manufacturing**	**3 0 0**	**3**
HUM	**19CSE358**	**Software Project Management**	**3 0 0**	**3**
HUM	**19CSE359**	**Financial Engineering**	**3 0 0**	**3**
HUM	**19CSE360**	**Engineering Economic Analysis**	**3 0 0**	**3**
HUM	**19CSE362**	**Information Systems**	**3 0 0**	**3**

FREE ELECTIVES OFFERED UNDER HUMANITIES / SOCIAL SCIENCE STREAMS

Cat.	Code	Title	L T P	Credit
HUM	19CUL230	Achieving Excellence in Life - An Indian Perspective	2 0 0	2
HUM	19CUL231	Excellence in Daily Life	2 0 0	2
HUM	19CUL232	Exploring Science and Technology in Ancient India	2 0 0	2
HUM	19CUL233	Yoga Psychology	2 0 0	2
HUM	19ENG230	Business Communication	1 0 3	2
HUM	19ENG231	Indian Thought through English	2 0 0	2
HUM	19ENG232	Insights into Life through English Literature	2 0 0	2
HUM	19ENG233	Technical Communication	2 0 0	2
HUM	19ENG234	Indian Short Stories in English	2 0 0	2
HUM	19FRE230	Proficiency in French Language (Lower)	2 0 0	2
HUM	19FRE231	Proficiency in French Language (Higher)	2 0 0	2
HUM	19GER230	German for Beginners I	2 0 0	2
HUM	19GER231	German for Beginners II	2 0 0	2
HUM	19GER232	Proficiency in German Language (Lower)	2 0 0	2
HUM	19GER233	Proficiency in German Language (Higher)	2 0 0	2
HUM	19HIN101	Hindi I	2 0 0	2
HUM	19HIN111	Hindi II	2 0 0	2
HUM	19HUM230	Emotional Intelligence	2 0 0	2
HUM	19HUM231	Glimpses into the Indian Mind - the Growth of Modern India	2 0 0	2
HUM	19HUM232	Glimpses of Eternal India	2 0 0	2
HUM	19HUM233	Glimpses of Indian Economy and Polity	2 0 0	2
HUM	19HUM234	Health and Lifestyle	2 0 0	2

HUM	**19HUM235**	**Indian Classics for the Twenty-first Century**	**2 0 0**	**2**
HUM	**19HUM236**	**Introduction to India Studies**	**2 0 0**	**2**
HUM	**19HUM237**	**Introduction to Sanskrit Language and Literature**	**2 0 0**	**2**
HUM	**19HUM238**	**National Service Scheme**	**2 0 0**	**2**
HUM	**19HUM239**	**Psychology for Effective Living**	**2 0 0**	**2**
HUM	**19HUM240**	**Psychology for Engineers**	**2 0 0**	**2**
HUM	**19HUM241**	**Science and Society - An Indian Perspective**	**2 0 0**	**2**
HUM	**19HUM242**	**The Message of Bhagwad Gita**	**2 0 0**	**2**
HUM	**19HUM243**	**The Message of the Upanishads**	**2 0 0**	**2**
HUM	**19HUM244**	**Understanding Science of Food and Nutrition**	**2 0 0**	**2**
HUM	**19JAP230**	**Proficiency in Japanese Language (Lower)**	**2 0 0**	**2**
HUM	**19JAP2313**	**Proficiency in Japanese Language (Higher)**	**2 0 0**	**2**
HUM	**19KAN101**	**Kannada I**	**2 0 0**	**2**
HUM	**19KAN111**	**Kannada II**	**2 0 0**	**2**
HUM	**19MAL101**	**Malayalam I**	**2 0 0**	**2**
HUM	**19MAL111**	**Malayalam II**	**2 0 0**	**2**
HUM	**19SAN101**	**Sanskrit I**	**2 0 0**	**2**
HUM	**19SAN111**	**Sanskrit II**	**2 0 0**	**2**
HUM	**19SWK230**	**Corporate Social Responsibility**	**2 0 0**	**2**
HUM	**19SWK231**	**Workplace Mental Health**	**2 0 0**	**2**
HUM	**19TAM101**	**Tamil I**	**2 0 0**	**2**
HUM	**19TAM111**	**Tamil II**	**2 0 0**	**2**

SYLLABUS

SEMESTER I

19ENG111	TECHNICAL COMMUNICATION	L-T-P-C: 2-0-3-3

Course Objectives

To introduce the students to the fundamentals of mechanics of writing
To facilitate them with the style of documentation and specific formal written communication
To initiate in them the art of critical thinking and analysis
To help them develop techniques of scanning for specific information, comprehension and organization of ideas
To enhance their technical presentation skills

Course Outcome

CO1: To gain knowledge about the mechanics of writing and the elements of formal correspondence.
CO2: To understand and summarise technical documents.
CO3: To apply the basic elements of language in formal correspondence.
CO4: To interpret and analyze information and to organize ideas in a logical and coherent manner.
CO5: To compose project reports/ documents, revise them for language accuracy and make technical presentations.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1										3				
CO2				1						2				
CO3										3				
CO4				1						2				
CO5									2	1				

Syllabus

Unit 1
Mechanics of Writing: Grammar rules -articles, tenses, auxiliary verbs (primary & modal) prepositions, subject-verb agreement, pronoun-antecedent agreement, discourse markers and sentence linkers
General Reading and Listening comprehension - rearrangement & organization of sentences

Unit 2
Different kinds of written documents: Definitions- descriptions- instructions-recommendations- user manuals - reports – proposals
Formal Correspondence: Writing formal Letters
Mechanics of Writing: impersonal passive & punctuation
Scientific Reading & Listening Comprehension

Unit 3

Technical paper writing: documentation style - document editing – proof reading - Organising and formatting
Mechanics of Writing: Modifiers, phrasal verbs, tone and style, graphical representation
Reading and listening comprehension of technical documents
Mini Technical project (10 -12 pages)
Technical presentations

Reference(s)

Hirsh, Herbert. L "Essential Communication Strategies for Scientists, Engineers and Technology Professionals". II Edition. New York: IEEE press, 2002
Anderson, Paul. V. "Technical Communication: A Reader-Centred Approach". V Edition. Harcourt Brace College Publication, 2003
Strunk, William Jr. and White. EB. "The Elements of Style" New York. Alliyan& Bacon, 1999.
Riordan, G. Daniel and Pauley E. Steven. "Technical Report Writing Today" VIII Edition (Indian Adaptation). New Delhi: Biztantra, 2004.
Michael Swan. '' Practical English Usage'', Oxford University Press, 2000

Evaluation Pattern

Assessment	Internal	External
Periodical 1	20	
Periodical 2	20	
*Continuous Assessment (Lab) (CAL)	40	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19MAT101	SINGLE VARIABLE CALCULUS	L-T-P-C: 1-0-0-1

Course Objectives

- Understand the various functions and their graphs.
- Understand the basic concept of continuous function and find the extreme values of the continuous functions.
- Understand the definite integral and various integration techniques.

Course Outcomes

CO1: To understand the concepts of single variable calculus.
CO2: To sketch graphs for functions using the concepts of single variable calculus and apply the fundamental theorem of calculus to evaluate integrals.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	3	---	---	---	---	---	---	---	---	---	---		
CO2	1	2	---	---	2	---	---	---	---	---	---	---		

Syllabus

Unit 1
Calculus
Graphs: Functions and their Graphs. Shifting and Scaling of Graphs. (1.5)
Unit 2
Limit and Continuity**:** Limit (One Sided and Two Sided) of Functions. Continuous Functions, Discontinuities, Monotonic Functions, Infinite Limits and Limit at Infinity. (2.1, 2.6)
Unit 3
Graphing : Extreme Values of Functions, Concavity and Curve Sketching, (4.1, 4.4).
Unit 4
Integration: Definite Integrals, The Mean Value Theorem for definite integrals, Fundamental Theorem of Calculus, Integration Techniques. (5.2 - 5.3, 8.1 – 8.5)

Text Book
Calculus', G.B. Thomas Pearson Education, 2009, Eleventh Edition.

Reference
'Calculus', Monty J. Strauss, Gerald J. Bradley and Karl J. Smith, 3rd Edition, 2002

Evaluation pattern
At the end of the course, a two-hour test will be conducted for 50 marks. The marks will be converted to 100 for grading.

19MAT106	ORDINARY DIFFERENTIAL EQUATION	L-T-P-C: 2-0-0-2

Course Objective

- To model mechanical systems using differential equations.
- To analyse and solve ordinary differential equations.
- To understand numerical methods for solving ordinary differential equations.

Course Outcomes

CO1: Understand the basic concepts of differential equations
CO2: Solve the ordinary differential equations using variation of parameters, undetermined coefficients and by numerical technique.
CO3: Understand the formation of modelling problems in ordinary differential equations and apply some standard methods to obtain its solutions.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2		2	3									
CO3	1	2	2	3								

Syllabus

Unit 1
Ordinary Differential Equations : Linear Differential Equations and Bernoulli Equation. Modelling Problems: Mixing Problem, Electric Circuits and vibration of strings.

Unit 2
Second Order Differential Equations: Euler-Cauchy Equations, Solution by Undetermined Coefficients, Solution by Variation of Parameters. System of ODEs, Basic Concepts and Theory, Homogeneous Systems and Non-homogeneous with Constant Coefficients. System of differential equations.

Unit 3
Computational Methods: Euler's methods, Runge-Kutta method.

Text Book
Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Tenth Edition, 2018.

Reference Books
'Engineering Mathematics', Srimanta Pal and Subhodh C Bhunia, John Wiley and Sons, 2012, Ninth Edition.
Advanced Engineering Mathematics by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.

Evaluation Pattern

Assessment	Weightage
Class Test/Assignment/Tutorial	30
End of course Test (2hrs)	70

19MAT102	MATRIX ALGEBRA	L -T-P-C: 2-0-0-2

Course Objectives

- Understand basic concepts of eigen values and eigen vectors.
- Apply eigen values and eigen vectors for diagonalization and quadratic form.
- Apply various iterative techniques to solve the system of equations.

Course Outcomes

CO1: Understand the notion of eigenvalues and eigenvectors, analyse the possibility of diagonalization and hence compute a diagonal matrix, if possible.
CO2: Apply the knowledge of diagonalization to transform the given quadratic form into the principal axes form and analyse the given conic section.
CO3: Understand the advantages of the iterative techniques and apply it to solve the system of equations and finding eigenvectors.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									
CO2	2	3	1									
CO3	3		1									

Syllabus

Unit 1
Review: System of linear Equations, linear independence.

Unit 2
Eigen values and Eigen vectors: Definitions and properties. Positive definite, negative definite and indefinite

Unit 3
Diagonalization and Orthogonal Diagonalization. Properties of Matrices. Symmetric and Skew Symmetric Matrices, Hermitian and Skew Hermitian Matrices and Orthogonal matrices.

Unit 4
Numerical Computations: L U factorization, Gauss Seidal and Gauss Jacobi methods for solving system of equations. Power Method for Eigen Values and Eigen Vectors.

Text Book
Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Tenth Edition, 2018.

Reference Books
Advanced Engineering Mathematics by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.
Engineering Mathematics', Srimanta Pal and Subhodh C Bhunia, John Wiley and Sons, 2012, Ninth Edition.

Evaluation Pattern

Assessment	Weightage
Class Test/Assignment/Tutorial	30
End of course Test (2hrs)	70

19CSE100	PROBLEM SOLVING AND ALGORITHMIC THINKING	L -T-P-C: 2-1-3-4

Course Objectives

- This course provides the foundations of computational problem solving.
- The course focuses on principles and methods thereby providing transferable skills to any other domain.
- The course also provides foundation for developing computational perspectives of one's own discipline.
-

Course Outcomes

CO1: Apply algorithmic thinking to understand, define and solve problems
CO2: Design and implement algorithm(s) for a given problem
CO3: Apply the basic programming constructs for problem solving
CO4: Understand an algorithm by tracing its computational states, identifying bugs and correcting them

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1												
CO2	3	2	3		3			3	3	3				
CO3	2	1												
CO4	1	1	2		2									

Syllabus

Unit 1
Problem Solving and Algorithmic Thinking Overview – problem definition, logical reasoning; Algorithm – definition, practical examples, properties, representation, algorithms vs programs.

Unit 2
Algorithmic thinking – Constituents of algorithms – Sequence, Selection and Repetition, input-output; Computation – expressions, logic; algorithms vs programs, Problem Understanding and Analysis – problem definition, input-output, variables, name binding, data organization: lists, arrays etc. algorithms to programs.

Unit 3
Problem solving with algorithms – Searching and Sorting, Evaluating algorithms, modularization, recursion. C for problem solving – Introduction, structure of C programs, data types, data input, output statements, control structures.

Text Book(s)
Riley DD, Hunt KA. Computational Thinking for the Modern Problem Solver. CRC press; 2014 Mar 27.

Reference(s)
Ferragina P, Luccio F. Computational Thinking: First Algorithms, Then Code. Springer; 2018.
Beecher K. Computational Thinking: A beginner's guide to Problem-solving and Programming. BCS Learning & Development Limited; 2017.
Curzon P, McOwan PW. The Power of Computational Thinking: Games, Magic and Puzzles to help you become a computational thinker. World Scientific Publishing Company; 2017.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19PHY101	ENGINEERING PHYSICS - A	L-T-P-C: 2- 1- 0- 3

Course Objectives

To enable the student to apply fundamental principles of electromagnetism, optics, modern physics including elements of quantum mechanics and its role in materials with specific focus on engineering applications.

Course Outcomes:

CO1: Understand and apply principles of electrodynamics.
CO2: Understand the elements of optics including phenomena of interference, diffraction and polarization.
CO3: Be exposed to the Einstein's theory of matter-radiation interaction and different types of lasers.
CO4: Be familiar with basic idea of quantum theory and its application to particle in a box and tunneling.
CO5: Acquire knowledge on fundamentals of crystal physics – free electron theory and the concept of energy band and fermi energy

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3										
CO 2	3	2										
CO 3	3	2	1									
CO 4	3	2										
CO 5	3	2	1									

Syllabus

Unit I: Electrostatics, Magnetostatics and Electrodynamics (15 hours)
Electric field and electrostatic potential for a charge distribution, divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential, Biot-Savart law, divergence and curl of static magnetic field, vector potential, Stoke's theorem, Lorentz force, Faraday's law and Lenz's law, Maxwell's equations.

Unit II: Waves and Optics (8 hours)
Huygens' Principle, superposition of waves and interference of light by wavefront splitting and amplitude splitting, Young's double slit experiment, Newton's Rings, Michelson interferometer.
Fraunhofer diffraction from single slit and circular aperture, Rayleigh criterion for limit of resolution and its application to vision, diffraction gratings and their resolving power.
Polarization: Unpolarised, polarized and partially polarized lights, polarization by reflection, double refraction by uniaxial crystals, Polaroid, half wave and quarter wave plates.

Unit III: Lasers (4 hours)
Einstein's theory of matter radiation interaction andAandBcoefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO_2), solid-state lasers (Ruby, Neodymium), dye lasers.

Unit IV: Quantum Mechanics (10 hours)
De Broglie waves, wave functions, wave equation, Schrodinger wave equation: time dependent and time independent form, operators – Eigen functions and Eigenvalues, uncertainty principle, particle in a finite potential one -dimensional box, tunnelling effect (Qualitative)

Unit V: Introduction to Solids (8 hours)

Crystal systems: Miller indices, crystal planes and directions, packing fraction, Classification of solids: Metals, semiconductors and insulators (qualitative), free electron theory of metals, Fermi level, Density of states, Kronig-Penney model and origin of energy bands.

Text Books:

1. *David J Griffiths "Introduction to Electrodynamics", 4th Edition, Pearson, 2015.*
2. *Ajay Ghatak, "Optics", 6th Edition, McGraw Hill Education India Private Limited, 2017.*
3. *Eugene Hecht, A R Ganesan, "Optics", 4th Edition, Pearson Education, 2008.*
4. *Arthur Beiser, ShobhitMahajan, S. RaiChoudhury"Concepts of Modern Physics", McGraw Hill Education India Private Limited, 2017.*
5. *Charles Kittel, "Introduction to Solid State Physics" 8th Edition, Wiley, 2012.*

Reference Books:

1. *Halliday, Resnick, Jearl Walker, "Principles of Physics", 10th Edition, Wiley, 2015.*
2. *John David Jackson, "Classical Electrodynamics", 3rd Edition, Wiley, 2007.*
3. *F A Jenkins, H E White, "Fundamental of Optics", 4th Edition, McGraw Hill Education India Private Limited, 2017.*
4. *David J Griffiths, "Introduction to Quantum Mechanics", 2nd Edition, Pearson Education, 2015.*
5. *M A Wahab, "Solid State Physics", 3rd Edition, Narosa Publishing House Pvt. Ltd., 2015.*

Evaluation Pattern:

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19PHY181	ENGINEERING PHYSICS LAB - A	L-T-P-C: 0-0-3 - 1

Course Objectives

- To introduce experiments for the understanding of physics concepts in the areas of electronics, optics, semiconductors, quantum mechanics and electricity and magnetism.
- To acquire experimental skills in studying electrical properties of metals and semiconductors, optical and quantum phenomena and measurement of magnetic field.

Course Outcomes

CO1: Be able to design and perform experiment to study the electrical property of metals and semiconductors.
CO2: Be able to design, perform experiments on dispersion, interference and diffraction.
CO3: Be able to design, perform experiments to measure magnetic field.
CO4: Perform experiment to study atomic spectrum of H_2 atom and quantum nature of light.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1									-	-
CO2	3	1	1	1									-	-
CO3	3	1	1	1									-	-
CO4	3	1	1	1										

List of Experiments

1. Carey Foster's bridge-finding resistance per unit length of the wire and to find the resistivity of the material of a given wire
2. Spectrometer-Dispersive power of prism.
3. Radius of curvature of given convex lens by Newton's rings method.
4. Laser- wavelength and particle size determination.
5. Band gap of a semiconductor.
6. Solar cell - efficiency and fill factor of the cell.
7. Verifying the quantum nature of hydrogen atom by measuring the wavelengths of spectral lines in Balmer series.
8. Photoelectric Effect-Planck's constant and work function of the given metal.
9. Measurement of the magnetic field of paired coils in a Helmholtz arrangement.

Evaluation Pattern

Assessment	Internal	End Semester
*Continuous Assessment (CA)	80	
End Semester		20

*CA-Basic principles of experiment, skill, result analysis and viva.

19CHY102	ENGINEERING CHEMISTRY - B	L-T-P-C: 2-1-0-3

Course Objectives

The main objective of the course is to impart knowledge on the fundamental concepts of chemistry involved in application of several important engineering materials that are used in the industry/day-to-day life.

Course Outcomes

CO1: To understand the fundamental concepts of chemistry to predict the structure, properties and bonding of Engineering materials**.**
CO2: To understand the principle of electrochemistry/photochemistry and applications of various energy Storage system.
CO3: To be able to understand the crystals structure, defects and free electron theory
CO4: To be able to understand the mechanism and application of conductivity polymer is various electronic devices.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2	2								2
CO 2	3	3	2	2								2
CO 3	3	3	3	3								2
CO 4	3	3	2	3								2

Syllabus

Unit 1

Atomic Structure and Chemical Bonding
Fundamental particles of atom – their mass, charge and location – atomic number and mass number – Schrondinger equation. Significance of ψ and ψ^2 – orbital concept – quantum numbers - electronic configuration. Periodic properties. Formation of cation and anion by electronic concept of oxidation and reduction – theories on bonding-octet, Sidwick and Powell, VSEPR and VBT-MOT. Formation of electrovalent, covalent and coordination compounds. Chemistry of weak interactions – van der Waals force and hydrogen bonding.

Unit 2

Electrochemical energy system
Faradays laws, origin of potential, electrochemical series, reference electrodes, Nernst equation, introduction to batteries – classification – primary, secondary and reserve (thermal) batteries. Characteristics – cell potential, current, capacity and storage density, energy efficiency. Construction, working and application of Leclanche cell-Duracell, Li-MnO_2 cell, lead acid batteries. Ni-Cd battery, Lithium ion batteries. Fuel cell - construction and working of PEMFC

Unit 3

Photochemistry and solar energy

Electromagnetic radiation. Photochemical and thermal reactions. Laws of photochemistry, quantum yield, high and low quantum yield reactions. Jablonski diagram - photophysical and photochemical processes, photosensitization, photo-polymerization and commercial application of photochemistry.
Solar energy - introduction, utilization and conversion, photovoltaic cells – design, construction and working, panels and arrays. Advantages and disadvantages of PV cells. DSSC (elementary treatment).

Unit 4

Solid state Chemistry
Crystalline and amorphous solids, isotropy and anisotropy, elements of symmetry in crystal systems indices - Miller indices, space lattice and unit cell, Bravais lattices, the seven crystal systems and their Bravais lattices, X-ray diffraction - Bragg's equation and experimental methods (powder method and rotating crystal technique), types of crystals - molecular, covalent, metallic and ionic crystals - close packing of spheres – hexagonal, cubic and body centred cubic packing, defects in crystals – stoichiometric, non-stoichiometric, extrinsic and intrinsic defects.

Unit 5

Polymer and composite Materials
Conducting polymers**:** Conducting mechanisms - Electron transport and bipolar polymers. Photoconductive polymers**:** Charge carriers, charge injectors, charge transport, charge trapping. Polymers for optical data storage - principles of optical storage, polymers in recording layer. Thermo sensitive polymers**:** Applications - Mechanical actuators and switches. Photo resists - Types - Chemically amplified photoresists -Applications. Magnetic polymers - structure and Applications. Liquid crystalline polymers**:** Fundamentals and process, liquid crystalline displays – applications. Organic LEDs-their functioning-advantages and disadvantages over conventional LEDs - their commercial uses. Piezo electric materials.

Text Books
Vairam and Ramesh "Engineering Chemistry", Wiley, 2012 Amrita Vishwa Vidyapeetham, Department of Sciences, "Chemistry Fundamentals for Engineers", McGraw Hill Education, 2015.

Reference Books
Jain and Jain, "Engineering Chemistry", DhanpatRai Publishing company, 2015
Puri, Sharma and Patania, " Principles of Physical chemistry", Vishal Publishing Co., 2017.
Atkins, "Physical Chemistry", OUP, Oxford, 2009

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19CHY182	ENGINEERING CHEMISTRY LAB - B	L-T-P-C: 0-0-3-1

Course Objective

The objective of the laboratory sessions is to enable the learners to get hands-on experience on the principles discussed in theory sessions and to understand the applications of these concepts in engineering.

Course Outcomes

CO1: Learn and apply basic techniques used in chemistry laboratory for small/large scale water Analyses / Purification.
CO2: To be able estimate the ions/metal ions present in domestic/industry waste water.
CO3: To utilize the fundamental laboratory techniques for analyses such as titrations, separation/purification\ and Spectroscopy.
CO4: To be able to analyze and gain experimental skill.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	3	2								2
CO 2	3	3	2	2								2
CO 3	3	3	3	3								2
CO 4	3	3	3	3								2

Lab:

1. Estimation of alkalinity in given water samples
2. Adsorption of acetic acid by charcoal
3. Potentiometric titration – acid-base/redox
4. Conductometric titration
5. Estimation of hardness by ion-exchange method
6. Determination of molecular weight of polymer
7. Determination of cell constant and unknown concentration of electrolyte
8. Estimation of tin from stannate solution
9. Separation techniques – TLC, Column chromatography
10. Verification of B-L law by UV-spectrophotometer

Evaluation Pattern

Assessment	Internal	End Semester
*Continuous Assessment (CA)	80	
End Semester		20

* CA – Principles of experiment, skill, result analysis and report

19MEE181	MANUFACTURING PRACTICE	L-T-P-C: 0-0-3-1

Course Objectives

- Introduce basic concepts pertaining to product dismantling and assembly.
- Familiarize with basic pneumatic components and design & validate simple pneumatic circuits.
- Familiarize with sheet metal tools and operations.
- Provide hands-on training on welding and soldering.
- Familiarize with plumbing tools and processes.
- Inculcate and apply the principles of 3D printing to build simple geometries.

Course Outcomes

CO1: Interpret the functionality of various components in a product through dismantling and assembly
CO2: Identify various pneumatic and electro-pneumatic components
CO3: Fabricate simple sheet metal objects using concepts of surface development
CO4: Perform metal joining operations using soldering and arc welding
CO5: Make simple plumbing joints for domestic applications
CO6: Build simple geometries using 3D printing tools

CO-PO MAPPING

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1							2	1		1	1		
CO2	2	2	1		1				2	1		1	1	1	
CO3	2	2							2	1		1	1		
CO4	2	1							2	1		1	1		
CO5	2		2		2							1	1	1	
CO6	2	2	1		1				2	1		1	1	1	

Syllabus

Product 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.

Pneumatic and PLC Workshop
Study of pneumatic elements-Study of PLC and programming. Design and simulation of simple circuits using basic pneumatic elements-Design and simulation of simple circuits using electro-pneumatics.

Sheet Metal Workshop
Study of tools and equipment - 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 practice.

Welding, Soldering and Plumbing Workshops

Study of tools and equipment - Study of various welding & soldering methods

Arc welding practice - fitting, square butt joint and lap joint - Soldering practice. Plumbing tools – Make a piping joint to a simple piping layout (should include cutting, threading and pipe fixing)

3D-Printing Workshop

Evaluation Pattern

Assessment	Internal	End Semester
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19MEE100	ENGINEERING GRAPHICS – CAD	L-T-P-C: 2-0-3-3

Course Objectives

- Familiarize with Bureau of Indian Standards (BIS) for creating engineering drawings
- Train the students on proper dimensioning and construction of simple geometries
- Inculcate with the concept of developing orthographic projections and isometric views using CAD drafting package

Note:

Drawing practice to be carried out using drafting package (Auto-CAD)
First angle projection to be followed

Course Outcomes

CO1: Understand the engineering drawing standards and their usage
CO2: Interpret engineering drawings
CO3: Construct and dimension 2-D geometries using CAD software
CO4: Improve coherent visualization skills
CO5: Inculcate with the concept of developing orthographic projections and isometric views

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	2	3	1	2	3		3	2	2	2
CO2	3	3	3	3		2	3	1	2	3		3	2	2	2
CO3	3	3	3	3	3	2	3	1	2	3		3	2	2	2
CO4	3	3	3	3		2	3	1	2	3		3	2	2	2
CO5	3	3	3	3	3	2	3	1	2	3		3	2	2	2

Syllabus

Unit 1
Basic principles of engineering drawing, Standards and conventions, lettering and types of lines, Introduction to drafting software, standard tool bar/menus, navigational tools. Co-ordinate system and reference planes. Creation of 2 dimensional drawing environment. Selection of drawing size and scale. Sketching of 2D simple geomentries, editing and dimensioning of 2D geomentries.

Unit 2
Orthographic Projections: Introduction, planes of projection, projection of points in all the four quadrants. Projection of straight lines, Projection of Plane Surfaces, Projection of regular solids, Sectioning of solids

Unit 3
Plan and elevation of simple buildings with dimensions

Text Book
BasantAgarwal and C M Agarwal., "Engineering Drawing", 2e, McGraw Hill Education, 2015

Reference Book(s)

Bhat N.D. and Panchal V.M. , " Engineering Drawing Plane and Solid Geometry , 42e, Charoatar Publishing House , 2010James D. Bethune, "Engineering Graphics with AutoCAD", Pearson Education, 2014
K.R. Gopalakrishna, "Engineering Drawing", 2014, Subhas Publications
Narayan K.L. and Kannaiah P, Engineering Drawing, SciTech Publications, 2003
John K.C., "Engineering Graphics for Degree", 1e, Prentice Hall India, 2009

Evaluation Pattern

Assessment	Internal	End Semester
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CUL101	CULTURAL EDUCATION – I	L-T-P-C: 2-0-0-2

Course Objective

- The course is designed as an introductory guide to the variegated dimensions of Indian cultural and intellectual heritage, to enable students to obtain a synoptic view of the grandiose achievements of India in diverse fields.
- It will equip students with concrete knowledge of their country and the mind of its people and instil in them some of the great values of Indian culture.

Course Outcomes

CO1: Be introduced to the cultural ethos of Amrita Vishwa Vidyapeetham, and Amma's life and vision of holistic education**.**
CO2: Understand the foundational concepts of Indian civilization like *puruśārtha*-s, law of karma and *varṇāśrama*.
CO3: Gain a positive appreciation of Indian culture, traditions, customs and practices**.**
CO4: Imbibe spirit of living in harmony with nature, and principles and practices of Yoga.
CO5: Get guidelines for healthy and happy living from the great spiritual masters

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3	2	3				2		
CO2						3	1	3				2		
CO3						3	1	3				2		
CO4						3	3	3				2		
CO5						3	1	3				2		

Syllabus

Unit 1
Introduction to Indian culture; Understanding the cultural ethos of Amrita Vishwa Vidyapeetham; Amma's life and vision of holistic education.

Unit 2
Goals of Life – Purusharthas; Introduction to Varnasrama Dharma; Law of Karma; Practices for Happiness.

Unit 3
Symbols of Indian Culture; Festivals of India; Living in Harmony with Nature; Relevance of Epics in Modern Era; Lessons from Ramayana; Life and Work of Great Seers of India.

Text Book
Cultural Education Resource Material Semester-1

Reference Book(s)
The Eternal Truth (A compilation of Amma's teachings on Indian Culture)

Eternal Values for a Changing Society. Swami Ranganathananda. BharatiyaVidyaBhavan.
Awaken Children (Dialogues with Mata Amritanandamayi) Volumes 1 to 9
My India, India Eternal. Swami Vivekananda. Ramakrishna Mission.

Evaluation Pattern:

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

SEMESTER II

19MAT111	MULTIVARIABLE CALCULUS	L-T-P-C: 2-0-0-2

Course Objective

- To understand parameterisation of curves and to find arc lengths.
- To familiarise with calculus of multiple variables.
- To use important theorems in vector calculus in practical problems.

Course Outcomes

CO1: Select suitable parameterization of curves and to find their arc lengths
CO2: Find partial derivatives of multivariable functions and to use the Jacobian in practical problems.
CO3: Apply Fundamental Theorem of Line Integrals, Green's Theorem, Stokes' Theorem, of Divergence Theorem to Evaluate integrals.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	---	---	---	---	---	---	---	---	---	---
CO2	1	2	---	---	2	---	---	---	---	---	---	---
CO3	2	2			3							

Syllabus

Unit 1

Functions of severable variables

Functions, limit and continuity. Partial differentiations, total derivatives, differentiation of implicit functions and transformation of coordinates by Jacobian. Taylor's series for two variables.

Unit 2

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.

Unit 3

Vector Integration

Line Integral, Line Integrals Independent of Path.
Green's Theorem in the Plane, Surfaces for Surface Integrals, Surface Integrals, Triple Integrals – Gauss Divergence Theorem, Stoke's Theorem.

Unit 4

Lab Practice Problems:
Graph of functions of two variables, shifting and scaling of graphs. Vector products. Visualizing different surfaces.

Text Book
Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Tenth Edition, 2018.

Reference Book(s)
Advanced Engineering Mathematics by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.
'Engineering Mathematics', Srimanta Pal and Subhodh C Bhunia, John Wiley and Sons, 2012, Ninth Edition.
'Calculus', G.B. Thomas Pearson Education, 2009, Eleventh Edition.

Evaluation Pattern

Assessment	Weightage
Class Test/Assignment/Tutorial	30
End of course Test (2hrs)	70

19MAT116	LAPLACE TRANSFORM	L-T-P-C: 1-0-0-1

Course Objectives

- Understand the definition Laplace transform and its properties.
- Apply Laplace transform to solve the differential equations.

Course Outcomes:

CO1: To understand the Laplace transform and its properties
CO2: Apply the Laplace transform to solve differential equations.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	---	---	---	---	---	---	---	---	---	---
CO2	1	2	---	---	2	---	---	---	---	---	---	---

Syllabus

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. (Sections: 6.1 to 6.7)
Lab Practice: Laplace transform for different functions.

Text Book:
Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Tenth Edition, 2018.

Reference Books:
'Engineering Mathematics', Srimanta Pal and Subhodh C Bhunia, John Wiley and Sons, 2012, Ninth Edition.
Advanced Engineering Mathematics by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.

Course Evaluation pattern:
At the end of the course, a two-hour test will be conducted for 50 marks. The marks will be converted to 100 for grading.

19CSE102	COMPUTER PROGRAMMING	L-T-P-C: 3-0-3-4

Pre-Requisite(s): 19CSE100 Problem Solving and Algorithmic Thinking

Course Objectives

- This course provides the foundations of programming.
- Apart from the usual mechanics of a typical programming language, the principles and methods will form the main focus of this course.
- Shift from learn to program to programming to learn forms the core of this course.

Course Outcome

CO1: Understand the typical programming constructs: data (primitive and compound), control, modularity, recursion etc. thereby to understand a given program
CO2: Understand and analyze a given program by tracing, identify coding errors and debug them
CO3: Make use of the programming constructs appropriately and effectively while developing computer programs
CO4: Develop computer programs that implement suitable algorithms for problem scenarios and applications

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1							1						
CO2	1	1	1					1						
CO3	1	2	2					2						
CO4	2	3	2					3						

Syllabus

Unit 1
Introduction and Review of C language constructs. Functions – inter function communication, standard functions, scope. Recursion – recursive definition, recurivse solution, designing recursive functions, limitations of recursion. Arrays – 1D numeric, searching and sorting, 2D numeric arrays.

Unit 2
Pointers: introduction, compatibility, arrays and pointers, Dynamic memory allocation, arrays of pointers, pointer arithmetic. Strings: fixed length and variable length strings, strings and characters, string input, output, array of strings, string manipulation functions, sorting of strings.

Unit 3
Structures: structure vs array comparison, complex structures, structures and functions, Union. Files and streams, file input output, command line arguments.

Text Book(s)
Forouzan BA, Gilberg RF. Computer Science: A structured programming approach using C. Third Edition, Cengage Learning; 2006.

Reference(s)
Byron Gottfried. Programming With C. Fourth Edition, McGrawHill,; 2018.

Brian W. Kernighan and Dennis M. Ritchie. The C Programming Language. Second Edition, Prentice Hall, 1988.
Eric S. Roberts. Art and Science of C. Addison Wesley; 1995.
Jeri Hanly and Elliot Koffman. Problem Solving and Program Design in C. Fifth Edition, Addison Wesley (Pearson); 2007.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE113	ELECTRICAL ENGINEERING PRACTICE	L-T-P-C: 1-0-3-2

Course Objectives

To develop practical skill in handling Electrical and Electronic appliances and installations.

Course Outcomes

CO1: Knowledge on electrical safety measures and familiarity with electrical tools, electronic components and their symbols.
CO2: Understanding of operation of electrical and electronic appliances.
CO3: Knowledge of domestic wiring and soldering practice.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3							1	3					
CO2	3							1	3					
CO3	3							1	3					

Syllabus

Electronics: Familiarization of electronic components (passive and active components), Resistor, Inductor and capacitor. Study of measuring instruments (Voltmeter, Ammeter and Multimeter). Verification of OHM's law. Measurement and theoretical Verification of series and parallel combination of resistors and capacitors. Familiarization of CRO and function generator, Rectifier circuits, Soldering and De-soldering practice.

Electrical:
Study on power supply and protective devices, Study on basic electrical tools and electrical accessories, Study on various lighting technologies, Study on house hold appliances: Iron box, Fan, Refrigerator, Air conditioner, Food Mixer/grinder

Domestic wiring practices: Glow an incandescent lamp using SPST switch, glow a fluorescent lamp using SPST switch, operate a fan and an incandescent lamp using two independent SPST switch, Operate a fluorescent lamp and a 3 pin socket using two independent SPST switch, Staircase wiring.

Evaluation Pattern

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE112	ELECTRIC CIRCUITS	L-T-P-C: 3-0-3-4

Course Objectives

To provide an understanding on operation and analysis of electrical circuits under steady state and transient conditions.

Course Outcomes:

CO1: Understanding of fundamental laws and characteristics of DC and AC electrical networks.
CO2: Ability to formulate electric circuit models and compute the steady state electrical quantities using network theorems and graph theory.
CO3: Ability to analyze behavior of electric circuits under transient conditions.
CO4: Ability to model and analyze three phase circuits and two port networks.
CO5: Ability to demonstrate network theorems, fabricate circuits and validate performance through simulation and hardware.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												
CO2	3	3	1		1									
CO3	3	3	1		1									
CO4	3	3	1		1									
CO5	3	2	1		2			1	2	1				

Syllabus

Unit 1
Review of circuit elements, fundamental laws, AC representations.
Steady state analysis of DC and AC circuits: Practice of Mesh Current and Node Voltage analysis of circuits with independent and dependent sources. Source transformation, Star-Delta Transformation, Network Theorems - Thevenin and Norton's theorems, Superposition theorem, Maximum Power Transfer Theorem, Tellegen's and Reciprocity Theorem

Unit 2
Graph Theory: Incidence matrix, Fundamental Tie-Set Matrix, Fundamental Cutset Matrix, Formulation of network equations using KCL and KVL.
Transient Analysis: Time domain analysis of first and second order circuits, Analysis of AC circuits using Laplace transforms, Case Study/Simulation.
Frequency response of series and parallel circuits: RLC Resonance, Q-factor and Bandwidth: Simulation.

Unit 3
Three phase systems – Three phase 3-wire and 4-wire circuits, balanced and unbalanced, Star and Delta connected source and loads, Phasor Diagrams.
Coupled circuits – Dot convention analysis.
Two-Port Networks: Z, Y, ABCD, hybrid and inverse hybrid parameters, interconnections and relationships among different network parameters.
Virtual lab platforms / simulation demos can be used for effective classroom teaching.

Lab Practice: Hardware/Simulation experiments in Kirchhoff's laws, Network Theorems, Transients, Resonance etc.

Text Books:

Alexander C K and Sadiku M N O, Fundamentals of electric circuits, 5th ed. New York, McGraw-Hill, 2013.

References:

Nahvi M and Edminister J, Schaum's Outline of Electric Circuits, 5th ed. New York, McGraw-Hill, 2011.
Hayt W, Kemmerly J, and Durbin S, Engineering circuit analysis, 7th ed. Boston, McGrawHill Higher Education, 2007.
Van Valkenburg M E, Network Analysis, 3rd ed. New Delhi, Prentice Hall-India, 2011.
Virtual labs, NPTEL Videos, Simulation demos etc.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE114	ELECTRONIC CIRCUITS	L-T-P-C: 3-0-3-4

Course Objectives:

To provide understanding of electronic devices such as diodes, BJTs and MOSFETs and familiarize with their applications.

Course Outcomes:

CO1: Understanding of the characteristics of electronic devices.
CO2: Ability to construct biasing circuits for transistor applications.
CO3: Ability to analyze frequency response of transistor amplifiers using small signal models.
CO4: Ability to design clipper, clamper, multivibrator and oscillator circuits.
CO5: Ability to develop feedback amplifier, voltage regulator and power amplifier circuits.
CO6: Ability to demonstrate electronic circuit performance through hardware and simulation.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3	3	1											
CO3	3	3	1											
CO4	3	3	2											
CO5	3	2												
CO6	3	2	2		3			1	2	1				

Syllabus

Unit 1
Diodes: Diode clipping and clamping circuits and Zener voltage regulators, Applications of Diodes: Design of Clipper, clamper circuits and Voltage Doubler.
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, Frequency response of CE amplifier. Emitter follower.

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, 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. Overview-Design and performance analysis of CMOS Inverter, Logic Gate circuits.

Unit 3
Power amplifier: Classification and Comparison in Class A, B, AB, D. Voltage References and Regulators: Design of linear power supplies, Characteristics of voltage regulators, Analysis of series voltage regulator. Feedback amplifiers, Oscillators - RC, LC and Crystal, Multivibrators - Analysis and Design of Bistable, Monostable, Astable Multivibrators and Schmitt trigger using transistors.

Lab Practice:
Practical way of classroom teaching using Virtual lab /Simulation demo may be used.
Hardware/Simulation experiments in Diode Applications, BJT Characteristics and Amplifier Design, MOSFET Switching characteristics, Regulators, Oscillators.

Text Books
Adel.S.Sedra, Kenneth.C. Smith, "Microelectronic Circuits", Oxford University Press, Fifth Edition, 2005.

References
Donald.E.Neaman, "Electronic Circuit, Analysis and Design", Tata McGraw Hill Publishing Company Limited, Second Edition, 2006.
David A. Bell, "Electronic devices and Circuits", 5th Edition, Oxford University Press India, 2008.
Thomas L. Floyd, David M. Buchla, Electronics Fundamentals: Circuits, Devices & Applications, 8th Edision, Pearson education
Virtual labs, NPTEL Videos, Simulation demos etc.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CUL111	CULTURAL EDUCATION – II	L-T-P-C: 2-0-0-2

Course Objective

- To deepen students' understanding and further their knowledge about the different aspects of Indian culture and heritage.
- To in still into students a dynamic awareness and understanding of their country's achievements and civilizing influences in various fields and at various epochs.

Course Outcome

CO1: Get an overview of Indian contribution to the world in the field of science and literature.
CO2: Understand the foundational concepts of ancient Indian education system.
CO3: Learn the important concepts of Vedas and *Yogasutra*-s and their relevance to daily life.
CO4: Familiarize themselves with the inspirational characters and anecdotes from the *Mahābhārata* and *Bhagavad-Gītā* and Indian history.
CO5: Gain an understanding of Amma's role in the empowerment of women

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3	3					2		
CO2						1		3				2		
CO3						3	3	3				2		
CO4						3	3	3				2		
CO5						1		1						

Syllabus

Unit 1
To the World from India; Education System in India; Insights from Mahabharata; Human Personality. India's Scientific System for Personality Refinement.

Unit 2
The Vedas: An Overview; One God, Many Forms; Bhagavad Gita – The Handbook for Human Life; Examples of Karma Yoga in Modern India.

Unit 3
Chanakya's Guidelines for Successful Life; Role of Women; Conservations with Amma.

Text Book
Cultural Education Resource Material Semester-2

Reference Book(s)

Cultural Heritage of India. R.C.Majumdar. Ramakrishna Mission Institute of Culture.
The Vedas. Swami ChandrashekharaBharati. BharatiyaVidyaBhavan.
Indian Culture and India's Future. Michel Danino. DK Publications.
The Beautiful Tree. Dharmapal. DK Publications.
India's Rebirth. Sri Aurobindo. Auroville Publications.

Evaluation Pattern:

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

SEMESTER III

19MAT214	Fourier Transform and Complex Analysis	L-T-P-C: 2-1-0-3

Course objectives

To understand the concepts of Fourier Series and Fourier transforms and its properties.
Apply the Fourier transform for some singles.
To perform calculus for complex variables.
To understand the residues and pole and evaluate the complete integrations.

Course Outcomes

CO1: Understand the periodic functions and obtain the Fourier series for certain functions.
CO2: Understand the Fourier transform and its properties and apply to some periodic signals.
CO3: Understand and carry out differentiation for complex functions.
CO4: Perform integral calculus in complex variables.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	---	---	---	---	---	---	---	---	---
CO2	1	2	1	---	2	---	---	---	---	---	---	---
CO3	2	1	2		1							
CO4	1	2	---	---	2							

Syllabus

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.

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.

Text Book
Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Ninth Edition, 2012.

Reference Book(s)
Advanced Engineering Mathematics by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.
Larry C. Andrews and Bhimson. K. Shivamoggi, The Integral Transforms for Engineers, Spie Press, Washington, 1999.

J. L. Schiff, The Laplace Transform, Springer, 1999.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE205	FUNDAMENTALS OF MECHANICAL ENGINEERING	L-T-P-C: 2-0-0-2

Course Objectives:

The objective of this is to understand the basic concepts of machine operation and mechanical system design, physical properties of force, motion, stress and elasticity. It also introduces the principles of equilibrium and thermodynamic laws.

Course Outcomes:

CO1: Apply the concept of equilibrium to systems which can be modelled as particles in 2D and to rigid bodies in 2D
CO2: Analyse simple statically determinate structures such as beams subject to various loadings and support conditions
CO3: Define the concepts of heat, work, and energy and discuss the first law of thermodynamics
CO4: Discuss the second law of thermodynamics. and explain the concept of entropy and principle of increase of entropy.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	2	1	-	-	-	-	-	3	2
CO2	3	3	1	3	1	1	1	-	-	-	-	-	2	2
CO3	2	3	1	1	1	1	1	-	-	-	-	-	2	3
CO4	3	3	3	2	1	2	1	-	-	-	-	-	3	3

Syllabus

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, free body diagram, Lami's Theorem. Statics of rigid bodies in two dimension- 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 Thermodynamics 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.

Textbooks:
R.C.Hibbeler. "Engineering Mechanics-Statics", Pearson Education Asia, 2012
Y.A. Cengel and Michael A. Boles, "Thermodynamics – An Engineering Approach", Tata McGrawHill, 2013

References:

J. L.Meriam & L.G Kraige. "Engineering Mechanics- Statics", 7th edition, Wiley India Pvt. Ltd, 2013

Beer and Johnston, "Vector Mechanics for Engineers", Tata Mc Graw Hill Publishing Company Ltd, 2012N.H Dubey. "Engineering Mechanics Statics and Dynamics" Mc Graw Hill, 2012

R.E. Sonntag, C. Borgnakka and G. J. Van Wylen, "Fundamentals of Thermodynamics", John Wiley and Sons, 2002.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE206	MATERIAL SCIENCE FOR ELECTRICAL ENGINEERING	L-T-P-C: 2-0-0-2

Course Objectives

This course helps to understand the structure and properties of materials used in Electrical Engineering.

Course Outcomes

CO1: Understand the structure and properties of conducting materials
CO2: Understanding semiconductors and its properties
CO3: Understand the classification of magnetic materials and its properties
CO4: Understanding properties of dielectric materials

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3													
CO3	3													
CO4	3													

Syllabus

Unit 1
Conducting Materials: The nature of chemical bond, crystal structure, Ohm's law and relaxation time, collision time, electron scattering and resistivity of metals, heat developed in a current carrying conductor, thermal conductivity of metals, superconductivity.

Semiconducting Materials: Chemical bonds in Si, Ge and its consequences, density of carriers in intrinsic semiconductors, carrier densities in n type semiconductors, Hall effect and carrier density

Unit 2
Magnetic Materials: classification, diamagnetism, magnetic dipoles, paramagnetic spin systems, ferromagnetism and coercive force, anti-ferromagnetic materials, ferrites and its applications

Dielectric Materials: Static dielectric constant, polarization and dielectric constant, internal fields in solids and liquids, piezoelectricity.

Text Book
J Decker, "Electrical Engineering Materials", PHI, Newdelhi, 1957

References
A.J.Decker, "Solid State Physics", Prentice Hall, Englewood Cliffs, 1957
F.K. Richtmyer E H Kennard, John N Copper, "Modern Physics" Tata Mc Graw Hill, 1995.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE202	ANALOG INTEGRATED CIRCUITS	L-T-P-C: 3-0-3-4

Course Objectives:

To provide fundamental knowledge of the characteristics and expose to linear and non-linear applications of operational amplifiers.

Course Outcomes:

CO1: Understanding of characteristics and parameters of operational amplifiers
CO2: Ability to design circuits for linear and non-linear applications using operational amplifiers.
CO3: Ability to analyze the frequency response characteristics of active filters.
CO4: Exposure to interpret special function integrated circuits.
CO5: Ability to demonstrate integrated circuit performance through hardware and simulation

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3	3	2	1										
CO3	3	3	1											
CO4	3	1	1											
CO5	3	2	2		3			1	2	1				

Syllabus

Unit 1
Operational amplifiers**:** Equivalent circuit, voltage transfer curve-Open loop Op-amp configurations –Voltage series, Voltage shunt feedback amplifiers configurations– Virtual lab experiments in inverting and non-inverting amplifier, 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 – hardware experiments.
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.
Specialized ICs and their applications, Monolithic Voltage Regulators - types and its applications
Practical way of classroom teaching using Virtual lab/ simulation platforms may be used.

Experiments on analog Integrated circuits – Opamp characteristics, Applications like adder, integrator, differentiators, comparators, Schmitt trigger, filters, Linear Voltage Regulator etc.

Textbook:

Ramakant A. Gayakwad, "Op-Amps and Linear integrated circuits", PHI, 4th Edition, 2000.

Donald.E.Neaman, "Electronic Circuit, Analysis and Design", Tata McGraw Hill Publishing Company Limited, Second Edition, 2002.

References:

Adel.S.Sedra, Kenneth.C.Smith, "Microelectronic Circuits", Oxford University Press, Fifth Edition, 2004.

Sergio Franco,"Design with operational amplifiers and Analog Integrated circuits",Tata McGraw Hill 3rd Edition 2002.

Ron Manchini, "Op-Amps for Everyone ", Design Reference-Texas Instruments, August 2002, Available from: http://www.ti.com/lit/an/slod006b/slod006b.pdf.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE204	ELECTRICAL MEASUREMENTS	L-T-P-C: 3-0-3-4

Course Objective:

To study the characteristics of basic electrical measuring instruments and to understand and apply concepts of transduction, signal conditioning and monitoring of electrical parameters.

Course Outcomes:

CO1: Understanding on the characteristics and standards of measurement systems
CO2: Familiarization with operation of electro-mechanical and electronic instruments
CO3: Ability to use transducers, Signal conditioning and signal monitoring in electrical measurements
CO4: Ability to apply modern digital methods in data acquisition systems for measuring electrical parameters.
CO5: Exposure to laboratory implementation of measurement systems and performance analysis through simulation and hardware.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-	1	-
CO5	2	-	-	-	3	-	-	1	3	-	-	1	-	-

Syllabus

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, Ayrton 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, potential transformer.

Measurement of Power and Energy: Different wattmeter connections in 3 phase circuits, EDM type wattmeter and Power factor meters, energy meter, calibration of meters.

Oscilloscope: Basic principle, CRT features, block diagram of oscilloscope, types, Digital storage oscilloscope, applications of CRO.

Transducers: Electrical 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, data transmission systems, advantages of digital transmission, time division multiplexing.

Virtual Lab Platform/ Simulation demos can be used for effective teaching in class room.

Lab exercises: Calibration of Wattmeter and Energy Meter. Extension of Instrument range using Voltmeter, Ammeter, Instrument transformers. AC and DC bridges, analog to digital conversion techniques, Study of Transducer, application of Transducer, Simulation of smart meters etc.

Textbook:

H.S Kalsi, "Electronic Instrumentation", Tata McGraw-Hill Publishing Company Limited, 2010.

E.W Golding and F.C Widdis, "Electrical measurements and measuring instruments", The English Language Book society, 5th Edition, 2011.

References:

A.K. Sawhney, "A Course in Electrical & Electronics Measurements and Instrumentation", Dhanpat Rai and Sons,2008.

Deobeling E.O, "Measurement systems, Applications and design", Tata McGraw-Hill Publishing Company Limited, 2004.

Evaluation pattern:

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE203	DIGITAL SYSTEMS	L-T-P-C: 3-0-3-4

Course Objective:

To acquire the basic knowledge of digital logic to analyze, design and implement combinational and sequential logic circuits and apply it to help societal development.

Course Outcomes:

CO1: Understand the basics concepts of digital systems.
CO2: Develop Boolean equations and truth tables for synthesis of logic functions and optimize the same using various minimization methods.
CO3: Analyze logic processes and implement logical operations using combinational logic circuits.
CO4: Synthesis and analysis of synchronous and asynchronous sequential circuits.
CO5: Implement digital circuits through simulation and hardware

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	2	1	-	-	-	-	-	-	-	-	-	-
CO5	3	3	3	1	1	-	-	1	2	1	-	-	-	-

Syllabus

Unit 1
Introduction to Logic Circuits, Logic Families: Logic Gates and Networks, Truth tables, Boolean algebra, Synthesis using logic gates, Design Examples, Introduction to Logic families such as ECL, TTL.
Implementation Technology: Transistor Switches, NMOS and PMOS logic gates, Introduction to CMOS Logic Gates, Negative Logic System, tri-state logic.
Optimized Implementation of Logic Functions: Karnaugh map, Strategies for minimization, incompletely specified Functions, Multiple – output Circuits, Tabular Method for minimization.
Number Representation and Arithmetic Circuits: Addition of unsigned Numbers, Signed numbers, Adder Circuits.

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, types of counters, Simple Control for MCB.
Synchronous Sequential Circuits: Basic Design Steps, State Assignment Problem, Mealy state Model, Moore State Model, Serial Adders Example, State minimization, Sequential Circuit design for drive control.

Unit 3
Asynchronous Sequential Circuits: Asynchronous Behavior, Analysis of Asynchronous circuits.

Virtual Lab Platform/ Simulation demos can be used for effective teaching in classroom.

Lab exercises: Verification of Boolean Theorems using basic gates, Design and implementation of combinational circuits using basic gates for arbitrary functions, code converters, multiplexers and de-multiplexers, Adder and Subtractor. Design and implementation of shift-registers, counters etc. Implementation on FPGA.

Textbook:

Stephen Brown, ZvonkoVranesic, "Fundamentals of Digital logic with Verilog Design", Tata. McGraw Hill Publishing Company Limited, Special Indian Edition, 2007.

References:

Morris Mano, "Digital Design", Pearson Education, Third Edition, 2006.
Donald D Givone, "Digital Principles and Design", Tata McGraw Hill Publishing Company Limited, 2003.
Allen Dewey, "Analysis and Design of Digital Systems with VHDL", PWS Publishing Company, 1999.
John F. Wakerly, "Digital Design Principles and Practices", Pearson Education, Third Edition, 2001.

Evaluation pattern:

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE201	ELECTROMAGNETIC THEORY	L-T-P-C: 3-0-0-3

Course Objective

To introduce different coordinate systems, concepts of electrostatic, magneto static and time varying electromagnetic fields.

Course Outcomes:

CO1: Understanding of coordinate systems, conversions and governing laws of Electric and Magnetic fields
CO2: Ability to analyze Electric and Magnetic field distributions using Maxwell's equations
CO3: Ability to evaluate electromagnetic and electrostatic fields in scalar and vector forms
CO4: Ability to formulate Travelling Waves in different media.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	1	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-	-	-

Syllabus

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.
Virual lab platforms /simulation demos/ animated videos can be used for effective classroom teaching.

Textbook:
N.Narayana Rao, "Elements of Engineering Electromagnetics", Sixth Edition, Pearson Education, 2006.

References:
David.K.Cheng, "Field and Wave Electromagnetics", Second Edition, Pearson Education, 2002.
William H.Hayt, John.A.Buck, "Engineering Electromagnetics", Seventh Edition, Tata 3. McGraw Hill. Publishing Company Limited, 2007.

Sadiku, "Elements of Electromagnetics", Second Edition, Oxford University press. 2007.

Evaluation Pattern:

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19AVP201	**AMRITA VALUES PROGRAMME I**	**1 0 0 1**
19AVP211	**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.

Course Outcome

CO1: Understanding the impact of *itihasas* on Indian civilization with a special reference to the *Adiparva* of Mahabharata
CO2: Enabling students to importance offighting*adharma* for the welfare of the society through Sabha and Vanaparva.
CO3: Understanding the nuances of dharma through the contrast between noble and ignoble characters of the epic as depicted in the Vana, Virata, Udyoga and Bhishma parvas.
CO4: Getting the deeper understanding of the Yuddha Dharma through the subsequent Parvas viz., Drona, Karna,Shalya, Sauptika Parvas.
CO5: Making the students appreciative of spiritual instruction on the ultimate triumph of dharma through the presentations of the important episodes of the MB with special light on Shanti, Anushasana, Ashwamedhika, Ashramavasika, Mausala, Mahaprasthanika and Swargarohana Parvas.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	2	2	3	3	3	-	3	-	-
CO2	-	-	-	-	-	3	3	3	3	2	-	3	-	-
CO3	-	-	-	-	-	3	2	3	3	3	-	3	-	-
CO4	-	-	-	-	-	3	-	3	3	3	-	3	-	-
CO5	-	-	-	-	-	3	-	3	3	2	-	3	-	-

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, Satyakama Jabala, 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.

TEXT BOOKS/REFERENCES:

Rajagopalachari. C, *The Ramayana*
Valmiki, *The Ramayana*, Gita Press

SEMESTER IV

19MAT216	PROBABILITY AND STATISTICS	L-T-P-C: 2-1-0-3

Course objectives

The course is expected to enable the students

- To understand discrete and continuous random variables and to compute important measures.
- To carry out various statistical tests and to draw practical inferences.

Course outcomes

CO1: To find out probabilistic measures of discrete and continuous random variables.
CO2: To conduct tests of hypothesis and tests of significance and to arrive at inferences.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1		1	1							2	1	1
CO2	1	1	1		1						1	1	2	1

Syllabus

Probability – Probability models and axioms, conditioning and Bayes' rule
Discrete random variables; probability mass functions; expectations, examples, multiple discrete random variables: joint PMFs, expectations, conditioning, independence

Continuous random variables, probability density functions, expectations, examples, multiple continuous random variables, continuous Bayes rule, covariance and correlation.
Statistics – Bayesian statistical inference, point estimators, parameter estimators, test of hypotheses, tests of significance.

Text book
Introduction to Probability, D. Bertsekas and J. Tsitsiklis, 2nd Edition, Athena Scientific, 2008.

Evaluation Pattern

Assessment	Weightage
Test 1 (after 15th lecture hr)	25
*Continues Assessment (CA)	25
Test 2 (after 30th Lecture hr)	50

*CA – Can be Quizzes, Assignments, Projects, and Reports

19EEE213	ELECTRICAL MACHINES I	L-T-P-C: 3-0-3-4

Course Objective:

To introduce fundamental concepts, operation and application of DC machines and transformers.

Course Outcomes:

CO1: Understanding of basic principles and construction of DC machines and transformers.
CO2: Ability to develop equivalent circuit and steady state equations of DC machines and transformers.
CO3: Ability to compute and analyze performance characteristics of DC machines and transformers.
CO4: Familiarity with selection and applications of DC machines and transformers.
CO5: Ability to validate performance ofDC machines and transformers through hardware and simulation.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3	2												
CO3	3	2	1											
CO4	3	2	1										1	
CO5	3	1	1		1			1	2	1				
CO6	3													

Syllabus

Unit 1
Basics of electric and magnetic circuits, Principles of electromechanical energy conversion, Basic concepts of rotating machines, DC Machines: Construction- EMF and Torque, Armature Reaction, Types and Characteristics of DC Generators and Motors, Starting, Speed Control and braking of DC Motors, Efficiency, Testing

Unit 2
Transformer: Construction and Practical Considerations, principle of operation, Transformer on No-Load, Ideal Transformer, Real Transformer and Equivalent Circuit, Performance evaluation-Losses, Transformer testing, Efficiency and Regulation, all day efficiency, Excitation phenomenon in transformers, Autotransformers, Three-phase Transformers, star-star, star-delta, Scott Connection, zig-zag connection, effect of transformer connections, Parallel operation of transformers, Harmonics and switching transients in transformers, Cooling methods.

Unit 3
Applications of DC machines and Transformer: Motors- selection considerations – Shunt, Series, Compound Motors, Universal motors, Permanent Magnet DC Machine, Electric traction, automotive, e-bike, applications-characteristics, speed control, breaking.
Transformer- Selection considerations, Instrument transformers, high frequency transformers, three winding transformers, tap changing transformers and voltage control, phase shifting transformers and load angle control.
Introduction to machine design- DC Machine and Transformers

Virtual/ Animation: -– Faraday's Law and Lenz Law, working principle of DC motor (Animation of elementary model) Armature reaction, DC motor/ Generator working, Mutual Induction principle, transformer working, Harmonics and switching transients in transformers.
Hardware: - DC Machines- Internal and External Characteristics, Speed control, Swinburn's test, Load test, Transformers: - Transformer OC & SC tests, Sumpner's test, All day efficiency, Parallel operation, Load test, Transformer Connections

Textbook:

Kothari D.P. and Nagrath I.J., "Electric Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi 2004.

References:

Stephen J. Chapman, 'Electric Machinery Fundamentals'4th edition, McGraw Hill Education Pvt. Ltd, 2010.
M.G. Say, "Performance and Design of Direct Current Machines", CBS publishers, New Delhi, 1993.
Fitzgerald A.E., Charles Kingsley, Jr. and Stephen D. Umans, "Electric Machinery", Tata McGraw-Hill Publishing Company Limited 2002
Albert E. Clayton, "The performance and design of direct current machines", Third Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 1992.
S.K. Bhattacharya, "Electrical Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi.
http://www.animations.physics.unsw.edu.au/jw/electricmotors.html

Evaluation Pattern:

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE214	SIGNALS AND SYSTEMS	L-T-P-C: 3-0-3-4

Course Objective:

To understand various types of signals and systems and analyse their properties using continuous and discrete transforms in time and frequency domain.

Course Outcomes:

CO1: Knowledge on classification of signals and systems
CO2: Ability to evaluate LTI output using linear convolution technique
CO3: Ability to analyse signals and systems in time and frequency domains.
CO4: Ability to evaluate theoretical concepts with simulation and laboratory experiments.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	2	-	3	-	-	1	2	-	-	-	-	-

Syllabus

Unit 1
Introduction: Integrated approach for continuous and 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.
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).

Unit 2
Review of Fourier series and Fourier Transforms-Applications-Case Study, Discrete Time Fourier transform and its properties, Introduction to DFT. 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,
z-Transform: Definition, ROC, Inverse z-Transform, Properties, Transform analysis of LTI Systems.
Interrelationship amongst different representation and Transforms.

Virtual Lab Platform/ Simulation demos can be used for effective teaching in classroom.

Lab Practice: Simulation Experiments on the generation of signals- ramp, sine, exponential, etc; Discrete Linear Convolution implementation; Fourier transform and Fourier Series; Power signal analysis using FT.

Textbook:

1.Simon Haykin, Barry Van Veen, "Signals and Systems", Second Edition, John Wiley and Sons, 2005.

References:

Alan V. Oppenheim, Alan S.Willsky ,S,Hamid Nawab, "Signals and Systems", Prentice Hall India Private Limited,2nd Edition, 1997.

Michael. J. Roberts, "Fundamentals of Signals and Systems", First Edition, Tata McGraw Hill Publishing Company Limited, 2007.

Rodger E. Ziemer, William H. Tranter D. Ronald Fannin, "Signals and Systems", Fourth Edition, Pearson Education, 2004.

Virtual labs, NPTEL Videos, Simulation demos etc.

Evaluation pattern:

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE212	ELECTRICAL ENERGY SYSTEMS I	L-T-P-C: 3-0-3-4

Course Objective:

To familiarize with the structure, operation and analysis of components in power system network.

Course Outcomes:

CO1: Understanding of the structure and operations of generation, transmission, distribution systems.
CO2: Familiarity with the behaviour of the load and tariff mechanism.
CO3: Ability to determine transmission line/cable parameters for various conductor configurations
CO4: Ability to and analyze the performance of power system components.
CO5: Ability to validate performance of power system network and components through simulation and hardware.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	1	-	-	-	-	-	-	-	-	-	-
CO4	3	3	1	1	-	-	-	-	-	-	-	-		
CO5	3	2	2	1	2	-	-	1	2	1	-	-	1	1

Syllabus

Unit1
Introduction-Structure of Electric Power System-Conventional, Deregulated Structure, Grid Structure Micro-grid and Smart Grid Structure; Methods of electric power generations – Conventional- Renewable Energy based generation, need for interconnected system- necessity of EHV transmission: EHVAC and HVDC transmission, Variable load on power system- Load Curve and Load Duration Curve, Tariff-Types, Power factor improvement.

Unit 2
Introduction to Modeling and performance analysis, Transmission line Models- Line parameter estimation- symmetrical and unsymmetrical spacing of lines, bundled conductor, double circuit lines- corona- Regulation, Efficiency, Real and reactive power flow in transmission lines- Harmonics- Effects in power system, THD. Compensation- shunt and series compensation.

Unit 3
Insulators and Underground cables -classification and grading. Mechanical design of transmission lines. Distribution systems –Types and comparison–Ring main- Radial distribution.
Representation of power system: Power system components model, Single line diagram and per unit representation, reactance/impedance diagram, Bus Admittance and Impedance matrix.
Virtual lab platforms / simulation demos can be used for effective classroom teaching.
Lab Practice: Hardware experiments, simulation experiments and field visit – Structure of Electric Power System, modeling and performance analysis of transmission and distribution systems, power system representation etc.

***Text Book*:**
John J. Grainger and Stevenson Jr. W. D, "Power System Analysis", McGraw Hill International edition, 2016

References:
HadiSaadat, "Power system analysis", McGraw Hill publishing company,2003
Kothari, D. P and Nagrath I J., 'Power System Engineering' Tata McGraw Hill Publishing Company, 2005
B.R.Gupta, "Power system analysis and design",S.Chand& Company Ltd.,2004.
Wadhwa C L 'Electric Power System', Wiley Eastern Limited, India 2007
L.L.Grigsby, "Electrical power engineering Handbook" ,IEEE press,2001.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE211	CONTROL SYSTEMS	L-T-P-C: 3-0-3-4

Course Objective

To introduce to the basics of control system design of LTI systems in time and frequency domains.

Course Outcomes:

CO1: Ability to model dynamic systems in time domain and frequency domain
CO2: Ability to analyze the system behavior in time and frequency domains
CO3: Ability to evaluate the stability of the control system.
CO4: Ability to design the compensators and controllers for desired response.
CO5: Ability to design control systems using hardware and simulation.

CO-PO Mapping

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	1	1	-	-	-	-	-	-	-	-	-	-
CO3	3	3	1	2	-	-	-	-	-	-	-	-	-	-
CO4	3	3	3	2	-	-	-	-	-	-	-	-	1	1
CO5	3	3	3	3	3	-	-	1	2	1	-	-	1	1

Syllabus

Unit 1
Introduction to control systems, Mathematical models of physical systems- transfer function representation. 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. Introduction to design of feedback systems, Lead-Lag compensation networks, PID controllers, state space representation, Controllability and observability. Control system design case studies - Turbine governor/ Robotic hand/ship steering, etc.
Lab Practice: Experiments in modelling, design and analysis of controllers using Simulation /Online platforms.

Textbook:
Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Pearson, 2011.

References:
Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
M. Gopal, "Modern Control System Theory", New Age International, 3rd edition 2014.

Norman S. Nise, "Control Systems Engineering", John Wiley & Sons PTE Ltd, 2013.
Nagrath.I.J, Gopal.M, "Control Systems Engineering", New Age Publishers 2017

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19SSK211	SOFT SKILLS I	L-T-P-C: 1-0-2-2

Course Outcomes

CO1: **Soft Skills:** At the end of the course, the students would have developed self-confidence and positive attitude necessary to compete and challenge themselves. They would also be able to analyse and manage their emotions to face real life situations.

CO2: **Soft Skills:** At the end of the course, the students would hone their presentation skills by understanding the nuances of content creation, effective delivery, use of appropriate body language and the art of overcoming nervousness to create an impact in the minds of a target audience.

CO3: **Aptitude:** At the end of the course, the student will have acquired the ability to analyze, understand and classify questions under arithmetic, algebra and logical reasoning and solve them employing the most suitable methods. They will be able to analyze, compare and arrive at conclusions for data analysis questions.

CO4: **Verbal:** At the end of the course, the students will have the ability to dissect polysyllabic words, infer the meaning, inspect, classify, contextualise and use them effectively.

CO5: **Verbal:** At the end of the course, the students will have the ability to understand the nuances of English grammar and apply them effectively.

CO6: **Verbal:** At the end of the course, the students will have the ability to identify, analyse and interpret relationship between words and use the process of elimination to arrive at the answer. They will also have the ability to judge, evaluate, summarise, criticise, present and defend their perceptions convincingly.

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								2	3	3		3
CO2									2	3		3
CO3		3		2								
CO4										3		3
CO5										3		3
CO6									3	3		3

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.

Textbook(s)

A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.
Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.
Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
The Hard Truth about Soft Skills, by Amazone Publication.
Quantitative Aptitude by R. S. Aggarwal,S. Chand
Quantitative Aptitude – Abijith Guha, TMH.
Quantitative Aptitude for Cat - Arun Sharma. TMH.

Reference(s)

Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.
More Games Teams Play, by Leslie Bendaly, McGraw Hill Ryerson.
The BBC and British Council online resources
Owl Purdue University online teaching resources
www.the grammarbook.com - online teaching resources www.englishpage.com- online teaching resources and other useful websites.

SEMESTER V

19EEE302	ELECTRICAL ENERGY SYSTEMS II	L-T-P-C: 3-0-3-4

Course Objective:

To introduce to power flow studies, fault analysis, stability analysis and economic operation of power systems.

Course Outcomes:

CO1: Understanding of computational techniques in power system analysis.
CO2: Ability to apply standard methods of load flow, fault analysis, stability analysis and economic operation.
CO3: Ability to analyze power system performance under steady state and transient conditions.
CO4: Ability to validate the performance, operation and control of power system network using modeling, simulation and hardware.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	1	1	-	-	-	-	-	-	-	-	-	-
CO3	3	3	2	3	-	-	-	-	-	-	-	-	1	1
CO4	3	3	3	2	2	-	-	1	2	1	-	-	1	-

Syllabus

Unit 1
Analysis of Power Networks in Steady State - Load flow analysis problem formulation, solution methods- Gauss seidel, Newton Raphson and Fast decoupled load flow methods. Concept of Economic operation of power system and load dispatch, Concept of optimal power flow, load frequency control.

Unit 2
Short circuit analysis – symmetrical faults – behavior of short circuit transients in generator and transmission line-unbalanced system- 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.
Improvement of power system performance: compensation techniques (passive, active)-Conventional and modern techniques
Virtual lab platforms / simulation demos can be used for effective classroom teaching.

Lab Practice: Hardware experiments, Simulation experiments and Case studies – load flow analysis, economic operation of power system, load frequency dynamics, power system transients, fault analysis, stability analysis etc.

Text Book:
John J. Grainger and Stevenson Jr. W. D, "Power System Analysis", McGraw Hill International edition, 2016.

References:
Hadisaadat, "Power System Analysis", McGraw Hill Publishing Company, 2003.
Kothari, D. P. and Nagrath, I.J., "Modern Power System Analysis", Fourth Edition, Tata McGraw Hill Publishing Company, 2011.
Wadwa, C.L., "Electrical Power Systems", Wiley Eastern Limited, India, 2007.
Kothari, D. P. and Nagrath, I.J., "Power System Engineering", Second Edition, Tata McGraw Hill Publishing Company, 2008.
Abhijith Chakrabarti, D.P.Kothari and A.K Mukhopadhyay, "An Introduction to Reactive Power Control and Voltage Stability in Power Transmission Systems", PHI learning private limited, India, 2010.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE304	POWER ELECTRONICS	L-T-P-C: 3-0-3-4

Course Objective

To impart knowledge on the characteristics of various power semiconductor devices, and, operation, design and synthesis of power conversion circuits for various applications.

Course Outcomes:

CO1: Understanding of static and dynamic characteristics of power semiconductor devices and various power electronic converters.
CO2: Ability to analyse the behaviour of various converters and their PWM control under different modes of operation.
CO3: Ability to evaluate the performance of power semiconductor devices, power converters with PWM operation for various applications.
CO4: Ability to design different converter circuits under various operating modes for various applications
CO5: Ability to validate various power converter operations and their control schemes using simulation and hardware.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	1	-	-	-	-	-	-	-	-	-
CO2	3	3	1	1	-	-	-	-	-	-	-	-	-	-
CO3	3	2	1	1	1	-	-	-	-	-	-	-	-	-
CO4	3	1	3	1	1	-	-	-	-	-	-	-	1	1
CO5	3	2	3	1	3	-	-	1	2	1	-	-	1	1

Syllabus

Unit 1
Power Semiconductor Switches: Power Transistors, Power MOSFET, IGBT, Thyristors - structure, turn on and turn off operation, steady state and switching characteristics. Introduction to wide band gap power semiconductor devices, Comparison and selection of controllable switches – Introduction to gate/base drive and Snubber Circuits - Power loss in switching devices, Temperature rise and use of heat sink.

Unit 2
Phase Controlled Converters: Single phase and Three phase Converters in CCM - performance parameters, DCM operation, Analysis of Single-phase converter with RL, RLE loads, Non-Sinusoidal Analysis - Inverter mode of operation - Effect of Source Inductance.
Single-phase AC Switching Controllers, R and RL Loads - Thyristor Controlled Inductor - Three phase application of Switching Control.
Choppers: - Step down chopper with R load and L filter - Steady state operation - average and ripple load current - back EMF loads - CCM and DCM, effect of frequency on CCM/DCM – Input filter - Step Up chopper: Analysis with CCM-. Applications of choppers, power factor correction.

Unit 3

Inverters: Applications - Half bridge inverter - full bridge inverter, Inverter control - square wave, simple pulse width modulation, sine PWM, schemes to generate triangular carrier and sinusoidal references. Unipolar and Bipolar voltage switching, performance parameters, AC and DC side currents, Sine PWM for three phase inverters. Current regulated modulation - Rectifier mode of operation, applications - ac side filter- Introduction to multilevel inverters.

Text Books

Ned Mohan, Tore M. Underland and William P. Robbins, "Power Electronics: Converters, Applications and Design", Fourth Edition, John Wiley & Sons.
Robert Erickson, Maksimovic D, "Fundamentals of Power Electronics", Springer Science, 2007

References:

L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.
Joseph Vidayathil "Power Electronics" Tata McGraw Hill, 2010.
Muhammed H Rashid, "Power Electronics- circuits, devices and applications" Third Edition.
Shaffer, Randall, "Fundamentals of Power Electronics with Matlab", Firewall media, 2013

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE301	DIGITAL SIGNAL PROCESSING	L-T-P-C: 3-0-3-4

Course Objective:

To expose to various digital signal processing techniques employed in real time applications.

Course Outcomes:

CO1: Understanding on frequency analysis of signals in discrete domain
CO2: Ability to apply FFT for frequency analysis of signals in discrete domain
CO3: Ability to design, analyze and build digital filters
CO4: Skill in simulation and programming of DSP algorithms and digital filters

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	3	1	1	-	-	-	-	-	-	-	-	-
CO4	3	3	2	2	3	-	-	1	2	1	1	-	-	-

Syllabus

Unit 1
Discrete Fourier Transforms: 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, 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 Filter realization, structures for realisation of discrete time systems, Structures for FIR systems -direct form structures, cascade form structures, frequency sampling structures, lattice structures. Structures for IIR systems, Direct, cascade and parallel form structures. 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. Application in power systems. Lab Practice: Simulation experiments on DFT, FFT, Filter design LPC etc.

Textbooks
Sanjit K. Mitra, "Digital Signal Processing, A Practical approach", Tata McGraw Hill Publishing Company Limited, 2005.

John G Proakis, G. Manolakis, "Digital Signal Processing Principles, Algorithms, Applications", Prentice Hall India Private Limited, Fourth Edition, 2007.

References

Allen V. Oppenheim, Ronald W. Schafer, "Discrete time Signal Processing" Prentice Hall India Private Limited, Fifth Edition, 2000.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE303	ELECTRICAL MACHINES II	L-T-P-C: 3-0-3-4

Course Objective:

To introduce to fundamental concepts, operation and application of AC machines.

Course Outcomes:

CO1: Understanding of construction and principle of operation of AC induction and synchronous machines.
CO2: Ability to develop equivalent circuit, phasor diagrams and steady state equations of AC machines.
CO3: Ability to compute and analyze performance characteristics of AC machines.
CO4: Familiarity with selection and applications of AC machines.
CO5: Ability to validate performance of AC machines through hardware and simulation.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3	2												
CO3	3	2	1											
CO4	3	2	1										1	
CO5	3	1	1		1			1	2	1				

Syllabus

Unit 1
Induction machines - Construction, principle of operation, squirrel cage and slip ring induction motors, time and space harmonics, starting and speed control, testing, circle diagram, equivalent circuit, performance curves, torque speed characteristics, induction generators.
Fractional horsepower motors, types, single phase Induction Motor, construction, starting, Equivalent circuit, performance evaluation, efficiency.

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
Applications of Induction and Synchronous machines: SEIG, DFIG, SRM, Electric traction, Motor Drives for Electric Vehicles, Linear Induction motor, shaded pole motors, hysteresis motor, universal motor, Permanent Magnet Synchronous Machine for wind energy application, synchronous condenser, synchronous motor drive applications
Introduction to machine design.
Virtual/ Animation: –– Concept of rotating magnetic field (RMF), Linear to rotating machine, working of induction motor, synchronous motor, and other induction machines
Hardware: - Induction Machines- Performance evaluation- Direct and indirect methods, testing, speed control methods, Synchronous Machines- Estimation of Regulation of synchronous generator, testing, Parallel operation, Synchronization of alternator.

Textbook:

1.Kothari D.P. and Nagrath I.J., "Electric Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi 2004.

References:

Stephen J. Chapman, 'Electric Machinery Fundamentals'4th edition, McGraw Hill Education Pvt. Ltd, 2010.

M.G.Say, "Performance and Design of Direct Current Machines", CBS publishers, New Delhi, 1993.

Fitzgerald A.E., Charles Kingsley, Jr. and Stephen D. Umans, "Electric Machinery", Tata McGraw-Hill Publishing Company Limited 2002

Albert E. Clayton, "The performance and design of direct current machines", Third Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 1992.

S.K. Bhattacharya, "Electrical Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19SSK301	SOFT SKILLS II	L-T-P-C: 1-0-2-2

Course Outcomes

CO1: **Soft Skills:** At the end of the course, the students will have the ability to communicate convincingly and negotiate diplomatically while working in a team to arrive at a win-win situation. They would further develop their inter-personal and leadership skills.

CO 2: **Soft Skills:** At the end of the course, the students shall learn to examine the context of a Group Discussion topic and develop new perspectives and ideas through brainstorming and arrive at a consensus.

CO3: **Aptitude:** At the end of the course, students will be able to identify, recall and arrive at appropriate strategies to solve questions on geometry. They will be able to investigate, interpret and select suitable methods to solve questions on arithmetic, probability and combinatorics.

CO4: **Verbal:** At the end of the course, the students will have the ability to relate, choose, conclude and determine the usage of right vocabulary.

CO5: **Verbal:** At the end of the course, the students will have the ability to utilise prior knowledge of grammar to recognise structural instabilities and modify them.

CO6: **Verbal:** At the end of the course, the students will have the ability to comprehend, interpret, deduce and logically categorise words, phrases and sentences. They will also have the ability to theorise, discuss, elaborate, criticise and defend their ideas.

Syllabus

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.

Textbook(s)

A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.
Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.
Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
The Hard Truth about Soft Skills, by Amazone Publication.
Quick Maths – Tyra.
Quicker Arithmetic – Ashish Aggarwal
Test of reasoning for competitive examinations by Thorpe.E. TMH

Non-verbal reasoning by R. S. Aggarwal, S. Chand

Reference(s)

Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova
More Games Teams Play, by Leslie Bendaly, McGraw Hill Ryerson.
The BBC and British Council online resources
Owl Purdue University online teaching resources
www.the grammarbook.com - online teaching resources www.englishpage.com- online teaching resources and other useful websites.

19LIV390	LIVE-IN-LAB I	L-T-P-C: 0-0-0-3

Course Objectives

- Identify and analyse the various challenge indicators present in the village by applying concepts of Human Centered Design and Participatory Rural Appraisal.
- User Need Assessment through Quantitative and Qualitative Measurements
- Designing a solution by integrating Human Centered Design concepts
- Devising proposed intervention strategies for Sustainable Social Change Management

Course Outcome

CO1: Learn ethnographic research and utilise the methodologies to enhance participatory engagement.
CO2: Prioritize challenges and derive constraints using Participatory Rural Appraisal.
CO3: Identify and formulate the research challenges in rural communities.
CO4: Design solutions using human centered approach.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3		3		1	1		3	3		3
CO2		3						3	3	3		
CO3		3					1		3	3		3
CO4	3		3				3	3	3	3		3

Syllabus

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) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth semester.
Thematic Areas

- Agriculture & Risk Management
- Education & Gender Equality
- Energy & Environment
- Livelihood & Skill Development
- Water & Sanitation
- Health & Hygiene
- Waste Management & Infrastructure

The objectives and the projected outcome of the project will be reviewed and approved by the department chairperson and a faculty assigned as the project guide.

Evaluation Pattern

Assessment	**Marks**
Internal (Continuous Evaluation) [75 marks]	
Workshop (Group Participation)	15
Village Visit Assignments & Reports	15
Problem Identification and Assessment	15
Ideation: Defining the Needs, Proposed Designs & Review	20
Poster Presentation	10
External [25 marks]	
Research Paper Submission	25
Total	**100**
Attendance (To be added separately)	5
Grand Total	**105**

SEMESTER VI

19EEE312	ELECTRIC DRIVES AND CONTROL	L-T-P-C: 3-0-3-4

Course Objectives:

To impart knowledge on DC and AC electric drives for various applications and identify right choice of electric drive for major applications.

Course Outcomes:

CO1: Understanding of the steady state and dynamic characteristics of AC, DC & special electrical drives and controls.
CO2: Ability to apply the fundamental concepts of AC and DC machines and various power converters for the development of electric drive systems.
CO3: Ability to analyse the performance of DC and AC motor drives under various operating conditions.
CO4: Ability to develop various controllers for DC and AC electric drives for different applications
CO5: Ability to validate various AC, DC drive & special electrical drives using simulation and hardware.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	1	1	-	-	-	-	-	-	-	-	-	-
CO4	3	1	3	1	1	-	-	-	-	-	-	-	1	1
CO5	3	1	2	2	3	-	-	1	2	1	-	-	1	1

Syllabus

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, Stepper Motor, introduction to the relevant converter circuits.

Hardware- DC Speed control- Converter fed DC motor – Induction motor drive- Speed Control-Closed loop and open loop.

Virtual lab/ Simulation - Phase controlled DC motor drives, Chopper controlled DC motor drives-modeling of DC motor-modeling of induction motor- Closed loop control of DC and AC Drives.

Textbook:

Gopal K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 2001.

References:

Pillay. S.K, A First Course on Electric Drives, Wilely Eastern Limited, Bombay, 2012
B.K Bose, 'Power Electronics and AC Drives', Prentice Hall, New Jersy, 2002.
V. Subrahmanyam,' Thyristor Control of Electric Drives',Tata McGraw Hill , New Delhi, 1988.
R.Krishnan, 'Electric Motor Drives, Modeling, Analysis and Control', Prentice Hall, NJ, 2001.
Muhammad H. Rashid, Power Electronics, Circuits, Devices and Applications, Third Edition, Pearson Education Press, 2004.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19ELC212	MICROCONTROLLERS AND APPLICATIONS	L-T-P-C: 3-0-3-4

Course Objectives:

To acquire the basic knowledge of designing microcontroller-based systems and apply it to implement real world applications.

Course Outcomes:

CO1: Understanding of concepts of processors and microcontrollers.
CO2: Ability to programPIC16F877A microcontroller.
CO3: Design a Microcontroller based system for various applications.
CO4: Ability to develop PIC16F877A applications through simulation and hardware.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	2	3	-	-	-	-	-	-	-	-	-
CO3	3	3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	3	3	2	3	-	-	1	2	1	2	1	1	1

Syllabus:

Unit1: Introduction to micro controllers- Architecture and programming, Register files, Memory Organisation, Tristate-logic, Buses-Memory Address register-Memory addressing-Read and write operations, ROM- RAM-PROM-EPROM-E2PROM.

Unit2: PIC16FXXX architecture, operation, data and program memory organization, special function registers, addressing modes, instruction set. Assembler, assembler directives, simple programs, conditional branching. Subroutines, nested subroutines, interrupt, ISR, priority.

Unit3: Peripherals: Port configuration, Parallel Slave Port, LED and Keyboard interface, Timers/Counters, WatchDog Timer, ADC, USART, CCP module. Introduction to 8051 micro controller: Architecture, Instruction Set, Interrupts, Ports, Timers.

Text Books:
Myke Predko, "Programming and customizing the PIC microcontroller", Tata McGraw Hill Publishing Company Limited, Third Edition, 2008.

References
T. R. Padmanabhan, "Introduction to microcontrollers and applications", First Edition, Narosa publishing house private limited, 2007.
PIC Micro mid Range MCU Family Reference Manual - Micro Chip Technology Inc.

Evaluation Pattern

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19MAT213	OPTIMIZATION TECHNIQUES	L-T-P-C: 3-0-0 3

Course Objective

To introduce various optimization methods applicable to engineering systems.

Course Outcome

CO1: Understanding of the logics of various optimization techniques.
CO2: Ability to formulate and solve optimization problems.
CO3: Ability to interpret and analyze the solutions of optimization algorithms.
CO4: Ability to use software tools in engineering design optimization problems.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	**PSO2**
CO1	3	1		-	-	-	-	-	-	-	-	-	-	-
CO2	3	3		1	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	2	-	-	-	-	-	-	-	-	-	-
CO4	3		1	-	2	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Introduction: Optimization – optimal problem formulation, engineering optimization problems, optimization algorithms, numerical search for optimal solution. graphical method, simplex method, Big M method, Two phase method.

Unit 2
Single variable optimization: Optimality criteria, bracketing methods- exhaustive search method, bounding phase method- region elimination method-interval halving, fibanacci search, golden section search, interpolation methods, point estimation method- successive quadratic search, gradient based method. Initial value problems for ordinary differential equations: single step methods, Taylor series method, Euler and modified Euler methods, fourth order Runge – Kutta method for solving first and second order equations. Case study and Simulation.

Unit3
Multivariable optimization: Optimality criteria, unconstrained optimization- solution by direct substitution unidirectional search- direct search methods, simultaneous uni-directional method- steepest descent method, shortest path algorithm Hook- Jeeves pattern search method, gradient based method. Newton's method, Conjugate gradient method, constrained optimization-Kuhn- Tucker, Lagrange multiplier method. Case Studies and simulation

Stochastic methods of optimization: random search methods, evolutionary computation-Introduction, Survival of the Fittest, Fitness Computation, Cross over, Mutation, Reproduction, Particle Swarm Optimization, Introduction to Multi-objective optimization. Case study and Simulation.

Text Book/ Reference(s)
S. S. Rao, "Optimization Theory & Applications", New Age international ltd. Publishers, Second edition, 1995
Kalyanmoy Deb, "Optimization for Engineering Design Algorithms & Examples" Prentice Hall of India, NewDelhi 2004.

Edwin K. P. Chong, and Stanislaw H. Zak, "An Introduction to optimization", Wiley- interscience series in discrete mathematics and optimization, second edition, 2004.
M. Asghar Bhatti, "Practical optimization methods with mathematics applications", Springer Verlag Publishers, 2000.
G. A Vijayalakshmi Pai & S. Rajashekharan " Neural Network, Fuzzy Logic, Genetic Algorithms Synthesis & Applications", PH India,2003.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and

19EEE313	INTRODUCTION TO PYTHON PROGRAMMING	L-T-P-C: 1-0-0-1

Course Objective:

To understand the basics of python programming

Course Outcomes:

CO1: Knowledge on typical programming constructs to understand a given program
CO2: Ability to analyze a given program by tracing, identifying coding errors and debugging.
CO3: Ability to develop computer programs for problem scenarios and applications

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1			2									
CO2	3	2	1	1	2				1					
CO3	3	2	2	2	2				1				1	1

Syllabus

Unit 1
Python basic syntax, interactive shell, editing, saving, and running a script.
The concept of data types; variables, assignments; immutable variables; numerical types; arithmetic operators and expressions; comments in the program; understanding error messages
Conditions, boolean logic, logical operators; ranges; Control statements: if-else, loops (for, while); short-circuit (lazy) evaluation; iterators and generators
Lists, tuples, and dictionaries; basic list operators, replacing, inserting, removing an element; searching and sorting lists; dictionary literals, adding and removing keys, accessing and replacing values; traversing dictionaries.
Design with functions: hiding redundancy, complexity; arguments and return values; formal vs actual arguments, named arguments. Recursive functions.

Unit 2
Strings and text files; manipulating files and directories, os and sys modules; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file (csv or tab-separated).
String manipulations: subscript operator, indexing, slicing a string; strings and number system: converting strings to numbers and vice versa.

Unit 3
Testing, Debugging, Exceptions, Assertions
Classes and OOP: classes, objects, attributes and methods; defining classes; design with classes, data modeling; persistent storage of objects

Textbook/References:
John Guttag, "Introduction to Computation and Programming Using Python: With Application to Understanding Data", Second Edition. MIT Press, 2016.
Tony Gaddis, "Starting Out with Python", Pearson, 3rd Edition, 2014.
Kenneth A. Lambert, "Fundamentals of Python: First Programs", Cengage Learning, 2nd Edition, 2018.
Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", O'Reilly Media, 2012.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE311 SOFTWARE BASED SOLUTIONS FOR ELECTRICAL ENGINEERING L-T-P-C: 0-0-3-1

Course Objectives:

Application of computer programming to solve real life problems in Electrical Engineering

Course Outcomes:

CO1: Develop coding skills in C, C++, Python
CO2: Solve real time problems in Electrical Engineering

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2			3			1	3	1	2	1	1	
CO2	2	2	3	2	3	3		1	3	1	2	1	2	2

Syllabus

Practice of coding in Python, C, C++ with relevant case studies and applications in Electrical engineering problems.

Evaluation Pattern

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE381	OPEN LAB	L-T-P-C: 0-0-3-1

Course Objective:

To empower with project management skills and develop ability to work in team. To introduce to advanced tools and procedures for technical writing and publications**.**

Course Outcomes:

CO1: Ability to develop an application by the acquired knowledge in core subjects
CO2: Ability to manage the time and cost of the product development
CO3: Ability to present the work in oral and written mode with proper clarity and justification
CO4: Ability to work as a team and effectively utilize the advanced tools.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	1	-	-	-	2	-	3
CO2	-	-	-	-	-	-	-	1	-	-	3	2	-	-
CO3	-	-	-	-	-	-	-	1	-	3	-	2	-	-
CO4	-	-	-	-	3	-	-	1	2	-	-	2	3	3

Syllabus

This is a hands-on section for the students. By the sixth semester, the students are adept in different core streams like Power Electronics, Power Systems, Electrical Machines, Energy Systems and 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.

Evaluation Pattern

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19SSK311	SOFT SKILLS III	L-T-P-C: 1-0-3-2

Course Outcomes:

CO1: **Soft Skills:** At the end of the course, the students will have the ability to prepare a suitable resume (including video resume). They would also have acquired the necessary skills, abilities and knowledge to present themselves confidently. They would be sure-footed in introducing themselves and facing interviews.

CO2: **Soft Skills:** At the end of the course, the students will have the ability to analyse every question asked by the interviewer, compose correct responses and respond in the right manner to justify and convince the interviewer of one's right candidature through displaying etiquette, positive attitude and courteous communication.

CO3: **Aptitude:** At the end of the course, students will be able to interpret, critically analyze and solve logical reasoning questions. They will have acquired the skills to manage time while applying methods to solve questions on arithmetic, algebra, logical reasoning, and statistics and data analysis and arrive at appropriate conclusions.

CO4: **Verbal:** At the end of the course, the students will have the ability to understand and use words, idioms and phrases, interpret the meaning of standard expressions and compose sentences using the same.

CO5: **Verbal:** At the end of the course, the students will have the ability to decide, conclude, identify and choose the right grammatical construction.

CO6: **Verbal:** At the end of the course, the students will have the ability to examine, interpret and investigate arguments, use inductive and deductive reasoning to support, defend, prove or disprove them. They will also have the ability to create, generate and relate facts / ideas / opinions and share / express the same convincingly to the audience / recipient using their communication skills in English.

Syllabus

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.

Textbook(s)

A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.

Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.
Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
The Hard Truth about Soft Skills, by Amazone Publication.
Data Interpretation by R. S. Aggarwal, S. Chand
Logical Reasoning and Data Interpretation – Niskit K Sinkha
Puzzles – Shakuntala Devi
Puzzles – George J. Summers.

Reference(s)

Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.
More Games Teams Play, by Leslie Bendaly, McGraw-Hill Ryerson.
The BBC and British Council online resources
Owl Purdue University online teaching resources

www.the grammarbook.com - online teaching resources www.englishpage.com- online teaching resources and other useful websites.

19LIV490	LIVE-IN-LAB II	L-T-P-C: 0-0-0-3

Course Objectives

- Proposal writing in order to bring in a detailed project planning, enlist the materials required and propose budget requirement.
- Use the concept of CoDesign to ensure User Participation in the Design Process in order to rightly capture user needs/requirements.
- Building and testing a prototype to ensure that the final design implementation is satisfies the user needs, feasible, affordable, sustainable and efficient.
- Real time project implementation in the village followed by awareness generation and skill training of the users (villagers)

Course Outcome

CO1: Learn co-design methodologies and engage participatorily to finalise a solution
CO2: Understand sustainable social change models and identify change agents in a community.
CO3: Learn Project Management to effectively manage the resources
CO4: Lab scale implementation and validation
CO5. Prototype implementation of the solution

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	3	3			1	3	3	3		3
CO2									3	3		
CO3									3	3	3	
CO4	3		3			3	1	3	3	3		3
CO5			1						3	3		

Syllabus

The students shall visit villages or rural sites during the vacations (after 6th semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth semester.
Thematic Areas

- Agriculture & Risk Management
- Education & Gender Equality
- Energy & Environment
- Livelihood & Skill Development
- Water & Sanitation
- Health & Hygiene
- Waste Management & Infrastructure

Evaluation Pattern

Assessment	**Marks**
Internal (Continuous Evaluation) [63 marks]	
1. Proposed Implementation	**2**
Presentation Round 1	
2. Proposal Submission + Review	**6**
3. Co-design	**6**
i. Village Visit I (Co-Design Field Work Assignments)	4
ii. Presentation of Co-design Assessment	2
4. Prototype Design	**14**
i. Prototype Design	4
ii. Prototype Submission	8
iii. Sustenance Plan	2
5. Implementation	**35**
i. Implementation Plan Review	3
ii. Implementation	24
iii. Testing & Evaluation	4
iv. Sustenance Model Implementation	4
External [37 marks]	
6. Research Paper	**18**
7. Final Report	**15**
8. Poster Presentation	**4**
Total	**100**
Attendance	5
Grand Total	**10**

19LAW300	INDIAN CONSTITUTION	L-T-P-C: P/F

Course Objectives

- To know about Indian constitution
- To know about central and state government functionalities in India
- To know about Indian society

Course Outcomes

CO1: Understand the functions of the Indian government
CO2: Understand and abide the rules of the Indian constitution
CO3: Understand and appreciate different culture among the people

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	3	2	3	-	-	-	-	-	-
CO2	-	-	-	-	-	3	2	3	-	-	-	-	-	-
CO3	-	-	-	-	-	3	2	3	-	-	-	-	-	-

Syllabus

Unit 1
Historical Background – Constituent Assembly Of India – Philosophical Foundations Of The Indian Constitution – Preamble – Fundamental Rights – Directive Principles Of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies For Citizens.

Unit 2
Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

Unit 3
State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts.

Text Book(s)
Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi.
R.C.Agarwal, (1997) "Indian Political System", S.Chand and Company, New Delhi.

Reference(s)
Sharma, Brij Kishore, "Introduction to the Constitution of India", Prentice Hall of India, New Delhi.

Evaluation Pattern

Assessment	Internal	External
Online Test	-	100
		P/F

SEMESTER VII

19EEE401	POWER SYSTEM PROTECTION AND SWITCH GEAR	L-T-P-C: 3-0-3-4

Course Objectives:

To provide knowledge on principles and schemes for protection in power systems.

Course Outcomes:

CO1: Understanding of operation on power system protection schemes and principles.
CO2: Ability to apply signal processing methods in protection schemes.
CO3: Ability to select protective relays and circuit breakers suitable for various applications.
CO4: Ability to develop suitable protection schemes for power system components.
CO5: Ability to demonstrate and analyze power system protection schemes through simulation and hardware.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	3	2												
CO3	3													
CO4	3	2	2											
CO5	3	2	2		1			1	2	1				

Syllabus

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.

Introduction to DC and AC microgrid islanding techniques.

Text Books:

Ravindra P Singh, "Switchgear and power system protection", Prentice Hall of India,2009.
Badriram, D.N. Vishwakarma, "Power system protection & switchgear" Tata McGraw Hill Publishing Company Ltd 2011.
T.S.M. Rao "Digital/Numerical Relays" Tata McGraw-Hill Education, 01-Jul-2005.
Y.G. Paithankar, S.R. Bhide, "Fundamentals of power system protection" Prentice Hall of India, 2004

References:

Sunil S Rao, 'Switchgear protection & power system' Khanna Publications.
A.S.Ingole, "Switchgear and protection" Umesh publications,2006.
C. Christopoulos& A Wright,' Electrical Power Systems Protection' Springer International Edition,2010.
Bhuvanesh A. Oza, "Power System Protection and Switchgear", Tata McGraw Hill, 2010.
Hadley, et al. "Securing Wide Area Measurement Systems", Pacific Northwest National Laboratory, June 2007.

Evaluation Pattern:

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19ENV300	ENVIRONMENTAL SCIENCE	L-T-P-C: P/F

Pre Requisite(s): Nil

Course Objectives

- To study the nature and facts about environment
- To appreciate the importance of environment by assessing its impact on the human world
- To study the integrated themes and biodiversity, pollution control and waste management

Course Outcomes

CO1: Ability to understand aspects of nature and environment
CO2: Ability to analyse impact of environment on human world
CO3: Ability to comprehend pollution control and waste management

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	3	2	3	-	-	-	-	-	-
CO2	-	-	-	-	-	3	2	3	-	-	-	-	-	-
CO3	-	-	-	-	-	3	2	3	-	-	-	-	-	-

Syllabus

Unit 1
Over view of the global environment crisis – Biogeochemical cycles – Climate change and related international conventions and treaties and regulations – Ozone hole and related International conventions and treaties and regulations – Over population – energy crisis – Water crisis – ground water hydrogeology – surface water resource development.

Unit 2
Ecology, biodiversity loss and related international conventions – treaties and regulations – Deforestation and land degradation – food crisis – water pollution and related International and local conventions – treaties and regulations – Sewage domestic and industrial and effluent treatment – air pollution and related international and local conventions – treaties and regulations – Other pollution (land – thermal - noise).

Unit 3
Solid waste management (municipal, medical, e-waste, nuclear, household hazardous wastes) – environmental management – environmental accounting – green business – eco-labelling – environmental impact assessment – Constitutional – legal and regulatory provisions – sustainable development.

Text Book(s)
R. Rajagopalan,"Environmental Studies – From Crisis to Cure", Oxford University Press, 2005, ISBN 0-19-567393-X.

Reference(s)
G.T.Miller Jr., "Environmental Science", 11th Edition, Cenage Learning Pvt. Ltd., 2008.
Benny Joseph, "Environmental Studies", Tata McGraw-Hill Publishing company Limited, 2008.

Evaluation Pattern:

Assessment	Internal	External
Online Test	-	100
		P/F

19MNG300	DISASTER MANAGEMENT	L-T-P-C: P/F

Pre-Requisite(s): None

Course Objectives

The objective of this course is to develop an understanding of human vulnerabilities to natural and induced disasters, their impact on the natural & social environment, strategic efforts to mitigate the impact, and recover from it.

Course Outcomes

CO1: To understand the typology of disasters, and the associated key concepts involving risk and recovery.
CO2: To understand the various strategic approaches for response to disasters.
CO3: To study and understand the bio-social health and sanitation aspects involved in the short- and long-term recovery from disasters.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						3	3	3				3		2	
CO2						3	3	3				3		2	
CO3						3	3	3				3		2	

Syllabus

Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, Capacity – Disaster and Development, and disaster management
Different Types of Disaster:
A) Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides.etc.
B) Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures (Building and Bridge), War & Terrorism etc. Causes, effects, and practical examples for all disasters.
Disaster Preparedness and Response: Disaster Preparedness: Concept and Nature; Disaster Preparedness Plan; Prediction, Early Warnings and Safety Measures of Disaster; Role of Information, Education, Communication, and Training; Role of Government, International and NGO Bodies; Role of IT in Disaster Preparedness, Role of Engineers on Disaster Management.
Disaster Response: Introduction; Disaster Response Plan; Communication, Participation, and Activation of Emergency Preparedness Plan; Search, Rescue, Evacuation and Logistic Management; Role of Government, International and NGO Bodies; Psychological Response and Management (Trauma,
Stress, Rumor and Panic); Relief and Recovery; Medical Health Response to Different Disasters
Reconstruction and Rehabilitation as a Means of Development; Damage Assessment; Post Disaster effects and Remedial Measures; Creation of Long-term Job Opportunities and Livelihood Options; Disaster Resistant House Construction; Sanitation and Hygiene; Education and Awareness; Dealing with Victims' Psychology; Long-term Counter Disaster Planning; Role of Educational Institute

Textbooks / References:

Dr. MrinaliniPandey, "Disaster Management", Wiley India Pvt. Ltd.
Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill Education (India) Pvt. Ltd.
Coppola D.P., "Introduction to International Disaster Management", Elsevier Science (B/H), 2007.
M.C. Gupta, "Manual on natural disaster management in India", NIDM, New Delhi
R.K. Bhandani, "An overview on natural & man-made disasters and their reduction", CSIR, New Delhi

Evaluation Pattern:

Assessment	Internal	External
Continuous Assesment	65	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE495	PROJECT PHASE I	L-T-P-C: 0-0-6 2

Course Objective

To comprehend, design, develop, implement and test the functionality of a project work and prepare a technical paper in an approved format and present it.

Course Outcome:

CO1: Ability to investigate an engineering problem and design/develop the proof of concept of its solution
CO2: Ability to estimate and manage the cost and time of the project
CO3: Ability to present the project with clarity and ethics in both oral and written mode
CO4: Ability to develop a team and effectively participate in the team to execute the project
CO5: Ability to support the environmental, social and engineering discipline through the project.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	-	-	-	-	-	3	3
CO2	-	-	-	-	-	-	-	-	-	-	3	-	3	3
CO3	-	-	-	-	-	-	-	3	3	3	-	3	3	3
CO4	-	-	-	-	-	-	-	3	3	-	-	-	3	3
CO5	-	-	-	-	3	3	3	3	3	-	-	3	3	3

Evaluation Pattern:

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

SEMESTER VIII

19EEE499	PROJECT PHASE II	L-T-P-C: 0-0-30-10

Course Objectives:

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 & Electronics Engineering covering design/development/realization/application/performance analysis/state-of-the-art technology.

Course Outcomes:

CO1: Ability to investigate on an engineering problem and suggest the proof of concept of its solution
CO2: Ability to estimate and manage the cost and time of the project
CO3: Ability to present the project with clarity and ethics in both oral and written mode
CO4: Ability to develop a team and effectively participate in the team to execute the project
CO5: Ability to support the environmental, social and engineering discipline through the project

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	-	-	-	-	-	3	3
CO2	-	-	-	-	-	-	-	-	-	-	3	-	3	3
CO3	-	-	-	-	-	-	-	3	3	3	-	3	3	3
CO4	-	-	-	-	-	-	-	3	3	-	-	-	3	3
CO5	-	-	-	-	3	3	3	3	3	-	-	3	3	3

Evaluation Pattern:

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

*CA – Can be Quizzes, Assignment, Projects, and Reports.

PROFESSIONAL ELECTIVES

POWER AND ENERGY SYSTEMS

19EEE331	SMART GRID AND IoT	L-T-P-C: 3-0-0-3

Pre-requisites: Energy Systems

Course Objective:

To understand and evaluate Smart Grid technologies.

Course Outcome

CO1: Understanding on fundamental concepts and challenges in smart grid
CO2: Familiarity with various smart grid technologies.
CO3: Exposure on standards and protocols for smart grid.
CO4: Knowledge on IoT applications and computational intelligence in smart grid

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	1	-	-	-	-	-	-	-	-	-	1	1
CO3	3	2	-	-	1	-	-	-	-	-	-	-	1	1
CO4	3	2	3	1	1	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Smart Grid: Comparison with existing grid, Concept of smart grid- Definition, Features, Applications, International policies, Opportunities & Barriers. Smart grid Architecture;

Unit 2
Smart grid Technologies Overview: Communication Technology- LAN, HAN, WAN , interoperability and Scalability; Advanced metering infrastructure (AMI), Energy Management System- SCADA, Wide area measurement systems (WAMS), Distributed energy resources (DERs), Energy Storage, Renewable Energy Integration, Electric Vehicle integration ; Demand Side management ; Smart grid: Protocols and Standards

Unit 3
IoT in Smart grid: IoT Architecture; IoT Messaging Protocols - MQTT, CoAP, AMQP, and DDS; IoT Hardware and Software; Data Analytics in the Smart Grid- Definition, Benefits, Tools, Challenges; need of artificial intelligence and machine learning for Smart grid applications, Standards for Information Exchange - Data Security methods; Introduction to cloud computing, edge computing, Multi-agent technology in Smart grid, Embedded web servers, Protocols for internet connectivity and interoperability, IPV6 and IPV4 protocols for internet connectivity. Case study in smart grid.

Text books/ References
Ali Keyhani, "Design of Smart Power Grid Renewable Energy Systems", John Wiley & Sons, IEEE Press, 2011.

James Momoh, "Smart Grid - Fundamentals of Design and Analysis", John Wiley & Sons, IEEE Press, 2012.
Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyam, Nick Jenkins, "Smart Grid Technology and Applications" John Wiley & Sons, 2012.
Clark W. and Gellings P. E., "The Smart Grid: Enabling Energy Efficiency and Demand Response", The Fairmont Press, Taylor & Francis, 2009.
IEEE Internet of Things Journal.
IEEE Power and Energy magazines.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE332	DEREGULATED POWER SYSTEMS	L-T-P-C: 3-0-0-3

Pre-requisites: Energy Systems

Course Objective

To expose to the deregulated power market operation, pricing mechanisms and electricity regulation and policies followed in India.

Course Outcome

CO1: Understanding of operation of deregulated power system and electricity market
CO2: Familiarity with Indian power sector acts, regulations and policies.
CO3: Ability to apply different pricing mechanism and market strategies.
CO4: Ability to evaluate techniques adopted in transmission congestion management, market settlement and tariff.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-		
CO3	3	3	-	-	-	-	-	-	-	-	-	-		
CO4	3	2	-	2	1	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Power Sector in India – Classical operation of power systems, least-cost operation, marginal cost, incremental cost - inter-utility interchanges. Fundamentals of deregulated power systems: Requirements and key issues - restructuring models - Independent system operators (ISOs).

Unit 2
Electricity market: Evolution and types of electricity markets - Competitive market - supply and demand functions, Market equilibrium - Market power and mitigation. Transmission Open Access: transmission pricing - pricing schemes - Concept of distribution factors – Location based marginal pricing.

Unit 3
Transmission capacity, Available Transfer capability (ATC) – Open Access Same Time Information Systems (OASIS) - Transmission congestion management - Ancillary Services: classifications and definitions – Indian Electricity Acts and Policies – 2003 Acts – Availability Based Tariff (ABT).

TEXT BOOKS / REFERENCES
Kankar Bhattacharya, Math H.J. Bollen and Jaap E. Daalder, "Operation of Restructured Power Systems", Springer, 2001.
M. Shahidehpour and M. Alomoush "Restructured Electrical Power Systems – Operation, Trading and Volatility", CRC Press, 2001.
Loe Lie Lai "Power Systems Restructuring and Deregulation", John Wily, 2001

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE333	HIGH VOLTAGE ENGINEERING	L-T-P-C: 3-0-0-3

Pre-requisites: Energy System I, II

Course Objectives:

To impart knowledge on high voltage generation, measurement and testing.

Course Outcomes:

CO1: Ability to formulate equations for uniform and non-uniform electric field and electric field in different geometric boundaries.
CO2: Ability to analyze the breakdown behavior of gas, liquid and solid dielectric materials.
CO3: Exposure to non-destructive test techniques for measuring dielectric properties.
CO4: Ability to test power apparatus used in high voltage applications.
CO5: Knowledge on standards and procedures for high voltage testing.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	2	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Syllabus:

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, 2014.

References:

C.L.Wadhwa , "High voltage Engineering", New age international (p) Ltd, Publishers,Reprint,2007
Kuffel.E and Abdullah.M, "High Voltage Engineering", Paragamon press, Oxford, London, 1970.
Gallghar.P.J. and Pearmain.A.J, "High voltage measurement, Testing and Design", John Wiley & Sons, NewYork, 1982.
Kuffel.E. and Zaengl.W.S, "High voltage Engineering. Fundamentals", Paragamon press, Oxford, London, 1986.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE334	DESIGN OF ELECTRICAL APPARATUS	L-T-P-C: 3-0-0-3

Pre-requisites: Electrical Machines I,II

Course Objective:

To impart knowledge on design of DC machines, transformer, induction motor and synchronous machine.

Course Outcomes:

CO1: Understanding of the basic design concepts of electrical machines.
CO2: Ability to develop comprehensive design of DC machines, transformer, induction motor and synchronous machines.
CO3: Ability to estimate design based performance of electrical machines.
CO4: Ability to develop optimized design using CAD.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2						-						
CO2	3	3	3					-						-
CO3	3	3	-	-			-							
CO4	3	2	3	-	1	-	-					-	1	1

Syllabus:

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. DC machine rotor and stator design using GUI softwares. 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. Transformer Design using software's.

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. Induction machine rotor design using GUI based softwares.
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. Synchronous machine rotor design using GUI softwares

Unit 3
Optimization techniques as applied to design of electrical machines; Study of cooling systems. Computer aided design: Advantage of computer aided design, CAD based machine drawing of basic electrical machines.

Text Books:

A. K. Sawhney and A. Chakarabarti 'A course in Electrical Machine Design', Dhanpat Rai & Co., New Delhi, Sixth edition 2006.

References:

Alexander Gray "Electrical Machine Design - The Design and Specification of Direct and Alternating Current", Gray Press, 2007.

JuhaPyrhonen, Tapani Jokinen, Valeria Hrabovcova "Design of Rotating Electrical machines" John Wiley & Son, 2009.

S. K. Sen, 'Principles of Electrical Machine Design with Computer Programmes'

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE335	POWER QUALITY & FACTS	L-T-P-C: 3-0-0-3

Pre-requisites: Energy Systems

Course Objective

To impart knowledge on different power quality issues, causes and mitigation techniques and to select suitable compensators for enhancement of power transfer capability and power quality**.**

Course Outcome

CO1: Understanding of causes and effects of power quality issues, and methods of compensation.
CO2: Exposure to international power quality standards and measuring techniques.
CO3: Ability to apply control schemes for various compensators.
CO4: Ability to analyse performance of conventional and FACTS devices for active and reactive power control and harmonic reduction.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-		-	-	-	-	-	-	-
CO2	3	2	-	-	1	-	-	-	-	-	-	-	-	-
CO3	3	3	1		1	-	-	-	-	-	-	-	-	-
CO4	3	3	1		1	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Review of power quality issues, definitions and standards, causes and effects of power quality issues, measurements. Harmonic studies: Fourier analysis, FFT Analysis. Improvement techniques: Conventional compensators, Passive and active compensators, shunt/series.

Unit 2
FACTS compensators: Shunt compensators: Passive/ variable impedance type Active/switched converter type. Series compensators: Passive/ variable impedance type. Active/switched converter type. Hybrid compensators. Harmonic Filters: Passive filters, tuned filters, design problems, Active filters-shunt, series, hybrid. Applications and Design problems. Estimation of rate/cost reduction due to hybrid filters.

Unit 3
Active filter control schemes/algorithms: Time-domain and Frequency-domain algorithms, AI based control algorithms, analog/digital implementation & Case studies. Review of improved power quality converters and applications. Custom power parks concept: Custom power devices and applications. Lab Experiments: Simulation and Hardware experiments in Conventional/FACTS/Harmonic compensators and controllers.

Text Books/ References
J.Arillaga, N.R.Watson and S.Chen, "Power System Quality Assessment", John Wiley & Sons, England, 2000.
Math J.Bollen, "Understanding Power Quality Problems-Voltage Sags and Interruptions", John Wiley & Sons, New Jersey, 2000.
Bhim Singh, Ambrish Chandra and Kamal Al-Haddad, "Power Quality: Problems and mitigation Techniques", Wiley 2015.

Enrique Acha and Manuel Madrigal,"Power Systems Harmonics-Computer Modeling and Analysis", John Wiley and Sons Ltd., 2001.
George J. Wakileh, "Power Systems Harmonics-Fundamentals, Analysis and Filter Design", Springer-Verlag, New York, 2001.
Selected Publications on Power Quality Improvement.
Ewald F. Fuchs and Mohammad A. S. Masoum, "Power Quality in Power Systems and Electrical Machines", 1st edition, Elsevier Academic Press, San Diego, USA, 2008, ISBN: 978-0-12-369536-9.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE336	POWER CONVERTERS	L-T-P-C: 3-0-0-3

Prerequisite: Power Electronics and Drives

Course Objective

To introduce the concepts and design of converters, feedback controllers, protection circuits, driver circuits and magnetic elements for switched mode power supply applications.

Course Outcome

CO1: Understanding of the principles of steady state and dynamic operation of isolated and non-isolated converters and various control techniques of power supplies.
CO2: Ability to analyze operation of isolated and non-isolated switch mode converters and resonant converter.
CO3: Ability to evaluate the performance of isolated and non-isolated switch mode converters and control schemes, and, resonant converters.
CO4: Ability to design converters, controller, protection, driver circuits and high frequency magnetic elements for SMPS.
CO5: Ability to validate isolated and non-isolated switch mode converters, various control schemes, protection, driver circuits and high frequency magnetic elements for SMPS using simulation and hardware.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	1	-	-	-	-	-	-	-	-	-	-
CO3	3	2	1	1	1	-	-	-	-	-	-	-	-	-
CO4	3	1	3	1	1	-	-	-	-	-	-	-	1	1
CO5	3	1	2	2	2	-	-	1	2	1	-	-	1	1

Syllabus

Unit 1
DC-DC Switched Mode Converters: Operating principles, Steady state analysis for continuous and discontinuous current operations, Performance calculations of Boost converter, Buck-boost converter, Cuk converter, SEPIC and Interleaved Converters, Comparison of DC-DC converters.

Unit 2
Switched Mode DC Power Supplies: Overview of linear and switched mode power supplies, Isolated converters: Flyback converter, Forward converter, Push pull converter, Half bridge converter & Full bridge converter.

Unit 3
Design of snubbers, drive circuits, design of high frequency inductors and transformers, Voltage feed forward - PWM control and current mode control, Feedback compensators and design, unity power factor rectifiers.
Introduction to resonant converters - classification of resonant converters - Basic resonant circuit concepts. Zero current and Zero voltage switching, introduction to ZVT.

Text Book(s)
Ned Mohan et.al, 'Power Electronics', Third edition, John Wiley and Sons, 2003.
Robert Erickson, Maksimovic D, "Fundamentals of Power Electronics", Springer Science, 2007

Reference(s)

L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.
George C. Chryssis, 'High Frequency Switching Power Supplies', McGraw-Hill International, 1999.
Abraham I. Pressman, 'Switching Power Supply Design', McGraw-Hill Company Inc, 1999.
Rashid, 'Power Electronics circuits, Devices, and Applications', Third Edition, Pearson Education, 2003

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE337	POWER SYSTEM MANAGEMENT	L-T-P-C: 3-0-0-3

Pre-requisites: Energy Systems

Course Objectives

To expose to energy management techniques, forecasting &economic aspects of power supply.

Course Outcomes

CO1: Exposure to Electricity Acts, regulations, business models and power supply reforms.
CO2: Ability to develop models for demand forecasting, energy storage, power pooling and trading
CO3: Ability to apply various power system management techniques and micro economics in power supply systems.
CO4: Familiarity with energy management, reactive power management and energy audit.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-		-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	1	1
CO3	3	2	-	-		-	-	-	-	-	-	-		
CO4	3	2	-	-	-	-	-	-	-	-	-	-		

Syllabus

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.

Text books / References
Pabla. A. S., "Electrical Power System Planning", Macmillan India Ltd, 1998.
Wood A. J. and Wollenberg B. F., "Power Generation, Operation and Control", Wiley Interscience, 1996.
Stoll H. G., "Least Cost Electric Utility Planning", Wiley Interscience, 1996.
Khan E., "Electrical Utility Planning and regulation", American Council for Energy Efficient Economy, Washington DC, 1968.
Heinz Weihrich, Harold Koontz, "Management – A Global Perspective", Tenth Edition, Tata McGraw Hill, 2001.

M. Shahidehpour and M. Alomoush, "Restructured Electric Power Systems – Operations , Trading and Volatility", CRC Press, 2001.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE338	POWER PLANT INSTRUMENTATION	L-T-P-C: 3-0-0-3

Pre-requisites: Energy Systems, Control Systems

Course Objective

To acquaint with theory and working principles of different types of instruments and control used in power plant automation.

Course Outcome

CO1: Familiarity with various components/equipment in power plants.
CO2: Understanding on process in different stages of power generation and transmission systems.
CO3: Familiarity with monitoring and control of boiler and turbine systems.
CO4: Exposure to automation of power plants.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	1	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	`-	-
CO4	3	-	1	-	2	-	-	-	-	-	-	-	2	-

Syllabus

Unit1
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.
Concept of regional and national power grid. Concept of distance protections and islanding types of power plant.
Instrumentation and Equipments of Various Unit Operations: Evaporation, Distillation, leaching, Gas Absorption, Heat exchangers, Humidification and Dehumidification, Drying, Size Reduction, Crystallization, Mixing.

Unit2
Boiler Instrumentation and Optimization: Combustion control, 3 element drum level control, steam pressure, oxygen/CO/CO_2 – flue gases control, furnace draft, boiler interlocks, Start-up and shut-down procedures Boiler load calculation, boiler efficiency calculation.
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.
Simulation experiments on SCADA, power plant monitoring and so on.

Text Book(s)

McCabe W.L, Smith J, Peter Harriot, "Unit operation of chemical Engineering", Seventh rev Edition, Tata McGraw Hill Publishing Company, , 2005.
Popovic and Bhatkar, "Distributed Computer control in Industrial automation", Second Edition, CRC Press, 1990.

Reference(s)

B.G.Liptak, "Instrument Engineers Handbook: Process Measurement and Analysis", Third Edition, Butterworth Heinemann, 1995.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE339	POWER SYSTEMS OPERATION, CONTROL & STABILITY	L-T-P-C: 3-0-0-3

Pre-requisites: Energy Systems

Course Objective:

To provide an insight into the relevance and possibilities of economic operation, control and stability aspects of power system.

Course Outcomes

CO1: Understanding of the principles of power system operation, control and stability.
CO2: Ability to develop mathematical model of power system controls.
CO3: Ability to carry out economic load dispatch and power system stability studies
CO4: Ability to design power system controllers

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	-	1	-	-	-	-	-	-	-		
CO3	3	2	1	1	1	-	-	-	-	-	-	-		
CO4	3	2	2	-	-	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Power system operation – state transition and control, SCADA in power systems-data acquisition, state estimation, security assessment and security enhancement – functions of control centers, - system load variations – system load characteristics
Economic load dispatch with and without losses – solution by iteration method (no derivation of loss coefficient) – Base point and participation factor. 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. Economic controller added to LFC. Need for Automatic Voltage regulator – various excitation systems-Modeling – static and dynamic analysis – Reactive power-voltage control devices.

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.

Text Book(s)
Olle I. Elgerd, "Electric Energy Systems Theory – An Introduction", Tata McGraw Hill Publishing company, 2004.
Prabha Kundur, "Power System stability and control", Tata McGraw Hill, 2008.

Reference(s)

Kothari, D. P. and Nagrath, I.J., "Modern Power System Analysis", Tata McGraw Hill Publishing Company, 2011.
Allen J. Wood and Bruce F. Wollenberg, "Power Generation Operation and Control", John Wiley & Sons, 1996.
L.K. Kirchmayer, "Economic operation of Power System", John Wiley & Sons, 1967.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE340	UTILISATION OF ELECTRIC ENERGY	L-T-P-C: 3-0-0-3

Course Objective:

To provide essential features of electric energy utilization in electric heating, welding, lighting and electric traction systems.

Course Outcomes:

CO1: Understanding of electrical energy conversion principles in various applications.
CO2: Ability to apply energy conversion principles in industrial applications.
CO3: Ability to design utilization systems for traction, lighting, welding and heating applications.
CO4: Ability to evaluate performance of energy utilization systems.
CO5: Exposure to energy conservation trends in electric power utilization.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-		
CO3	3	2	2	-	-	-	-	-	-	-	-	-		
CO4	3	3		-	-	-	-	-	-	-	-	-		
CO5	3	2		-	-	-	-	-		-	-	-		

Syllabus

Unit 1
Electric Heating – Comparison with other heating methods; Resistance heating, Induction heating, Arc furnace, Dielectric heating; Electric welding – types, equipment and modern techniques, 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 2
System of electric traction and track electrification: DC system, Single phase system, three phase system, Composite system, Kando system; Maglev, Psedo levitation, Diamagnetic levitation, 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; Spacecraft/Ship on-board power generation and distribution, Emergency Power Supply, Electrical Safety.

Unit 3
Electric Lighting - Definition of terms; laws of illumination; Luminaries; Lighting requirements; Illumination levels; lamp selection and maintenance; Lighting schemes, calculations& design, Train lighting systems, Special requirements of train lighting, methods of obtaining unidirectional polarity constant output, single battery system, Double battery parallel block system, Coach wiring, lighting by using 25KV AC Supply.

Textbook:

N. V. Suryanarayana, "Utilization of Electric Power including Electric Drives and Electric Traction" New Age InternationalLimited Publishers, New Delhi, India,2014

References:

Howard B Cary and Scott C Helzer, "Modern Welding Technology", Prentice Hall, 2004
Craig DiLouie, "Advanced Lighting Controls: Energy Savings,Productivity,Technology and Applications", CRC Press, 2005
William C. Whitman, William M. Johnson "Refrigeration & Air Conditioning Technology", Thomson Delmar,2005
H Partab, "Modern Electric Traction", Dhanpat Rai & Sons 2007
Raunek Kantharia, "A Guide to Ship's Electro-Technology: Part 1" Marine Insight©, 2013
EHJ Pallett, "Aircraft Electrical Systems" Pearson India Education Services Pvt.Ltd, 2015

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE341	RENEWABLE ENERGY AND ENERGY CONSERVATION	L-T-P-C: 3-0-0-3

Course Objectives

To introduce to electric power generation from renewable energy sources and familiarize to the concepts of electrical energy conservation.

Course Outcomes

CO1: Understanding of the energy scenario, renewable energy conversion and electrical energy conservation.
CO2: Knowledge on the characteristics of renewable energy sources and model the resource potential
CO3: Familiarity with renewable energy conversion and energy conservation technologies
CO4: Ability to compute and analyze performance of renewable energy conversion schemes and energy Conservation methods.
CO5: Ability to design captive renewable energy conversion systems and industry specific energy conservation schemes.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	2	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	2	-	-	-	-	-	-	-
CO3	3	-	1		-	-	2	-	-	-	-	-	-	-
CO4	3	2	1	1	-	-	2	-	-	-	-	-	1	1
CO5	3	2	3	1	-	-	2	-	-	-	-	-	1	1

Syllabus

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. Extra terrestrial 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. Simulation case studies.

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. Small WEGs — stand-alone and hybrid system. Simulation case studies

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. Case studies.

TEXT BOOKS / REFERENCES

Thomas B Johansson et al, 'Renewable Energy sources for fuel and electricity-, Earthscan Publishers, London,1993

J W Twidell and A D Weir "Renewable Energy Resources", ELBS, 1998

G. N. Tiwari, M. K Ghosal, "Fundamentals of renewable energy sources", Alpha Science international Ltd, 2007

Garg H P, Prakash J., "Solar Energy: Fundamentals & Applications", Tata McGraw Hill, New Delhi, 1997

Kastha D, Banerji S and Bhadra S N, "Wind Electrical Systems", Oxford University Press, NewDelhi,1998

ony Burton, David Sharpe, Nick Jemkins and Ervin Bossanyi, "Wind Energy Hand Book", John Wiley & Sons, 2004

S. C. Tripathy, "Electric energy utilization and conservation", Tata McGraw Hill Publishing company Ltd.,1987

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE342	DESIGN OF ELECTRICAL SYSTEMS	L-T-P-C: 3-0-0-3

Pre-requisites: Energy System I, II

Course Objective:

To impart knowledge on techno-economic aspects and sizing of electrical distribution systems meeting the national and international standards.

Course Outcomes:

CO1: Understanding of usage of standards and specifications of electrical distribution system.
CO2: Ability to estimate the demand and protection limits in distribution systems and components.
CO3: Ability to determine sizing of transformer, switch gear and protection systems in electric distribution system.
CO4: Ability to carry out soft tool based distribution system design.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-		-	-	-	-	-	-	-	-	-	-
CO3	3	2	1	-	-	-	-		-	-	-	-		
CO4	3	-	1	-	2	-	-		-	-	-	-		

Syllabus

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 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 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 the fault current and the total fault current, IEC equations, the impact of CB status on fault levels. Simulation for Short circuit calculations, SC analysis.

Unit3
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 1.1kV cable, Voltage drops in 415V motor, feeders

and voltage drop based ampacity, the use of copper cables for motors of rating less than 7.5kW. Simulations based for GUI for calculating sizing of cables.

Text Books/ References:

N. Balasubramanian "Design of electrical systems (for large projects)", Revised edition, The Rukmini studies, Chennai 1999.
M.K. Giridharan, "Electrical Systems Design", 3rd Edition, I K International Publishing House Pvt. Ltd, 2015.
M. V. Deshpande, "Electrical Power System Design", Tata McGraw-Hill, 2006.
J. B. Gupta, A Course in Electrical Installation Estimating and Costing, S.K. Kataria & Sons; Reprint 2013 edition (2013).
K. B. Raina, S. K. Bhattacharya, Electrical Design Estimating Costing, NEW AGE; Reprint edition (2010).
Tamil Nadu Electricity Board (TNEB) reference manual
EEE Hand Book.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE343	MANAGEMENT OF POWER DISTRIBUTION	L-T-P-C: 3-0-0-3

Course Objectives:

To introduce energy economics and power sector acts, regulations and reforms.

Course Outcomes:

CO1: Exposure to Electricity Acts, regulations and distribution reforms.
CO2: Ability to develop models for demand forecasting, energy storage, power pooling and trading.
CO3: Ability to apply various power system management techniques and micro economics in distribution networks.
CO4: Familiarity with data acquisition systems and smart metering.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-		-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	1	1
CO3	3	2	-	-		-	-	-	-	-	-	-		
CO4	3	2	-	-	-	-	-	-	-	-	-	-	1	1

Syllabus

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.

Text Books / References:
Pabla. A. S., "Electrical Power System Planning", Macmillan India Ltd, 1998.
Heinz Weihrich, Harold Koontz, "Management – A Global Perspective", Tenth Edition, Tata McGraw Hill, 2001.
IEEE Working Group on distribution automation, IEEE Tutorial course 88EH0280-8-PWR, 1998.
M. Shahidehpour and M. Alomoush, "Restructured Electric Power Systems – Operations, Trading and Volatility", CRC Press, 2001.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE344	ENERGY STORAGE SYSTEMS	L-T-P-C: 3-0-0-3

Course objectives

To understand the importance and application of energy storage systems and to familiarize with different energy storage technologies.

Course Outcome

CO1: Awareness of the role of energy storage in power systems.
CO2: Familiarity with different storage technologies and its applications.
CO3: Ability to apply energy storage technology in renewable energy integrations and smart grids
CO4: Ability to analyze the performance of Energy storage Systems
CO5: Exposure to economics of energy storage.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3													
CO3	3	2	1											
CO4	3	2	1	1									1	1
CO5	3	1												

Syllabus

Unit 1
Introduction to energy storage for power systems: Applications of energy storage systems, Components of Energy Storage Systems, Types of storage technologies: Thermal, Mechanical, Chemical, Electrochemical, Electrical. Efficiency of energy storage systems. Overview on Electrical energy storage: Batteries, Super capacitors, Superconducting Magnetic Energy Storage (SMES).

Unit 2
Energy storage systems- configurations and applications. Charge and discharge mechanism of Batteries, Comparison of storage systems - Energy density, power density Storage for renewable energy Integration: Solar energy, Wind energy, Electric vehicle. Energy storage in Microgrid and Smart grid.

Unit 3
Management of storage systems, Battery Management Systems, Management of Hybrid Energy Storage Systems (HESS), Increase of energy conversion efficiencies by introducing energy storage, Storage technology for energy management, Economics of Energy storage.

TEXT BOOKS/ REFERENCES:
A.G.Ter-Gazarian, "Energy Storage for Power Systems", Second Edition, The Institution of Engineering and Technology (IET) Publication, UK, (ISBN - 978-1-84919-219-4), 2011.
Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt," Energy Storage in Power Systems" Wiley Publication, ISBN: 978-1-118-97130-7, Mar 2016.
A. R. Pendse, "Energy Storage Science and Technology", SBS Publishers & Distributors Pvt. Ltd., New Delhi, (ISBN - 13:9789380090122), 2011.

Electric Power Research Institute (USA), "Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits" (1020676), December 2010.
Paul Denholm, Erik Ela, Brendan Kirby and Michael Milligan, "The Role of Energy Storage with Renewable Electricity Generation", National Renewable Energy Laboratory (NREL) - A National Laboratory of the U.S. Department of Energy - Technical Report NREL/ TP6A2-47187, January 2010.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

EMBEDDED CONTROL AND AUTOMATION

19EEE351	ADVANCED CONTROL SYSTEMS	L-T-P-C: 3-0-0-3

Pre-requites: Control Systems

Course Objective:

To introduce the basics of linear and nonlinear control systems in state space framework.

Course Outcomes:

CO1: Understanding of concept of state space, behavior of nonlinear system and adaptive control concepts.
CO2: Ability to model linear and nonlinear systems in state space framework.
CO3: Ability to solve state equation.
CO4: Ability to analyze the stability of non-linear systems.
CO5: Ability to design state feedback controller and state observers.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3	3	2		1									
CO3	3	3			1									
CO4	3	3	2	3	2								1	1
CO5	3	3	3	3	2								1	1

Syllabus

Unit 1
State space modeling: 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
State space analysis: Derivation of transfer function from state model, 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
State space design- Pole placement technique: stability improvements by state feedback, necessary and 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, Liapunov stability criteria. Introduction to adaptive and optimal control techniques. State space modelling, design and analysis of advanced controllers using Simulation /Online platforms.

Textbook:

Katsuhiko Ogata, "Modern Control Engineering", fifth edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2015.

References:

Franklin and Powell. "Feedback Control of Dynamics Systems", seventh edition Addison-Wesley, 2017.
Di Stefano. Feedback Control Systems. Schaum's outline, Second Edition, McGraw- Hill Education, 2014.
Luenberger. Introduction to Dynamic Systems. Wiley.
Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Pearson, 2011.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE352	DIGITAL CONTROL SYSTEMS	L-T-P-C: 3-0-0-3

Pre-requites: Control Systems

Course objective

To characterize the discrete-time system in both time and frequency domains and design digital controllers.

Course Outcomes:

CO1: Understanding of sampling process and Z-transform.
CO2: Ability to solve the pulse transfer function of discrete time systems.
CO3: Ability to analyze the behavior and stability of discrete time systems in Z-plane.
CO4: Ability to apply lag-lead compensation in closed loop systems for the desired time/frequency response.
CO5: Ability to design of digital state-feedback controller and state-observers.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	3	2	2	-	-	-	-	-	-	-	-	-
CO4	3	3	3	2	2	-	-	-	-	-	-	-	1	1
CO5	3	3	3	-	2	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Review of Z-transforms. Pulse transfer function. Digital control system: sampling, quantization, data reconstruction and filtering of sampled signals. Mathematical modeling of sampling process. Simulation examples- effect of sampling rate.

Unit 2
Stability analysis of closed loop systems in the z- plane: root loci, frequency domain analysis, Stability tests. Discrete equivalents. Digital controller design for SISO systems: design based on root locus method in the z-plane, design based on frequency response method, design of compensators, design of PID Controller.

Unit 3
2DOF discrete PID controller- software approach. State space representation in discrete system. Controllability, observability, control law design, decoupling by state variable feedback, effect of sampling period. Estimator/ Observer Design: full order observers, regulator design. Discrete LQR design. Simulation experiments in controller, observer/estimator, discrete LQR design and so on.

Text Books:
K. Ogata, "Discrete-Time Control Systems", Pearson Education, 2011.
Gene F. Franklin, J. David Powell, Michael Workman, "Digital Control of Dynamic Systems", Pearson, 3rd Edition, 2006.

References:

M. Sami Fadali, Antonio Visioli, "Digital Control Engineering: Analysis and Design", Elsevier, 2013.

IoanDoré Landau, GianlucaZito, "Digital Control Systems: Design, Identification and Implementation", Springer, 2006.

Cheng Siong Chin, "Computer-Aided Control Systems Design" CRC Press, 2013.

Hemchandra Madhusudan Shertukde, "Digital Control Applications-Illustrated with MATLAB" CRC Press Inc., 2015.

C. L. Philips, Troy Nagle, AranyaChakrabortty, "Digital Control System Analysis and Design", Prentice-Hall, 2014.

M. Gopal, "Digital Control and State Variable Methods", Tata McGraw-Hill, 2012.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE353	PROCESS CONTROL AND INSTRUMENTATION	L-T-P-C: 3-0-0-3

Pre-requites: Control Systems

Course Objective:

This course covers basics of process control and instrumentation, followed by modelling of various systems and design of controllers for different applications.

Course Outcomes:

CO1: Ability to develop transfer function and state-space models for linear dynamic processes
CO2: Understanding on feedback and feedforward controllers
CO3: Ability to design PID controllers using different tuning rules
CO4: Ability to evaluate the performance of control loop systems.
CO5: Familiarization of automation in process control

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	1	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	3	-	1	-	-	-	-	-	-	-	-	
CO4	3	3	3	2	1	-	-	-	-	-	-	-	-	
CO5	3	1	-	-	2	-	-	-	-	-	-	-	1	

Syllabus

Unit 1
Process Modelling: hierarchies. Theoretical models: transfer function, state space models, and time series models. Development of empirical models from process data, chemical reactor modelling. Identify the various instrumentations required for process control.

Unit 2
Feedback & feed forward control, cascade control, selective control loops, ratio control, feed forward and ratio, split range, selective, override, auctioneering, adaptive and inferential controls. Multi-loop and multivariable control: process interactions, Singular value decomposition, Relative gain array, I/O pairing. Decoupling and design of non-interactive control loops. PID design, tuning, trouble shooting, tuning of multiloop PID control systems. Decoupling control: strategies for reducing control loop interactions.

Unit 3
Instrumentation for process monitoring: codes and standards, preparation of process flow, P&I diagrams. Statistical process control, supervisory control, direct digital control, distributed control, PC based automation. Programmable logic controllers: organization, programming aspects, ladder programming, final control elements. SCADA in process automation. Case studies.
Lab Practice: Simulation/hardware experiments in PID controller, PLC and so on.

Text Books/ References:

Dale E. Seborg, Duncan A. Mellichamp, Thomas F. Edgar, Francis J. Doyle "Process Dynamics and Control", John Wiley & Sons, 2015.

Stephanopoulos, G., " Chemical Process Control: An Introduction to Theory and Practice ", Prentice-Hall, New Jersey, 2012.

Ernest O. Doebelin, "Measurement Systems Application and Design", McGraw Hill International Editions, 5th edition, 2014.

Johnson D Curtis, "Process Control Instrumentation Technology", Prentice Hall India, 2013.

W. Bolton, "Mechatronics", Pearson, 6th Edition, 2015

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE354	INTRODUCTION TO ROBOTICS	L-T-P-C: 3-0-0-3

Pre-requisites: Matrix Algebra

Course Objective:

This course introduces the fundamentals, kinematic and inverse kinematic control of manipulators and mobile robots.

Course Outcomes:

CO1: Understanding of mathematical modeling of rigid bodies
CO2: Learning on kinematic and inverse kinematic models of manipulators
CO3: Exposure to systems and navigation of wheeled mobile robots

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	1	-	1	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	1	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Mathematical representations of rigid bodies in 3D space, the concept of a 4 x 4 homogeneous transformations and elementary screw theory. Lab: Simulations of different kinds of actuators and their mathematical models.

Unit 2
Fundamentals of kinematics, Symbolic representation of robots: representation of joints, link representation using D-H parameters, kinematics of serial robot. Direct Kinematics: forward solutions for Stanford and PUMA robots, Inverse Kinematics: inverse (back) solution by Geometric approach with co-ordinate transformation and manipulation of symbolic T and A matrices.

Unit 3
Wheeled mobile robots: Kinematic models of holonomic and non-holonomic mobile robots, modeling of slip. Introduction to ROS.
Case Study: Application of modern control systems on wheeled mobile robots: Navigation of differential drive mobile robots, Software simulation and hardware demonstration.

Text Books/ References:
"A Mathematical Introduction to Robotic Manipulation", Richard Murray, Zexiang Li and S. Shankar Sastry,2015
Dale E. Seborg, Duncan A. Mellichamp, Thomas F. Edgar, Francis J. Doyle "Process Dynamics and Control", John Wiley & Sons, 2015.
Stephanopoulos, G., " Chemical Process Control: An Introduction to Theory and Practice ", Prentice-Hall, New Jersey, 2012.
Ernest O. Doebelin, "Measurement Systems Application and Design", McGraw Hill International Editions, 5th edition, 2014.
Johnson D Curtis, "Process Control Instrumentation Technology", Prentice Hall India, 2013.
W. Bolton, "Mechatronics", Pearson, 6th Edition, 2015

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE355	MECHATRONICS	L-T-P-C: 3-0-0-3

Pre-requites: Control Systems

Course Objective:

To integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems by using the concepts of instrumentation.

Course Outcomes:

CO1: Understanding of fundamentals of sensors and actuators for mechatronic system
CO2: Ability to develop the mathematical models for dynamic systems
CO3 : Ability to design controllers for mechatronic systems
CO4 : Exposure to applications of mechatronic systems

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	1	1	-	-	-	-	-	-	-	-	-
CO3	3	2	3	1	1	-	-	-	-	-	-	-	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Mechatronics, sensors and transducers: Introduction to Mechatronics Systems – Measurement Systems – Control Systems – Displacement, Potentiometer LVDT, Encoders, Hall Effect, Capacitive Transducers, Microprocessor based Controllers - Applications. Sensors and Transducers – Performance Terminology – Sensors for Displacement, Position and Proximity; Velocity, Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature, (thermistor, thermocouple) Light Sensors – Selection of Sensors.

Unit 2
Actuation systems: Pneumatic and Hydraulic Systems – Directional Control Valves – Rotary Actuators. Mechanical Actuation Systems – Cams – Gear Trains – Ratchet and Pawl – Belt and Chain Drives – Bearings. Electrical Actuation Systems – Mechanical Switches – Solid State Switches – Solenoids – D.C Motors – A.C Motors – Stepper Motors - Servomotors.
System models and controllers: 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
Programming logic controllers: 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 – Application of PLCs for control.

Design of mechatronics system: 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 – Automatic Camera – Automatic Washing Machine - Engine Management Systems.

Text Book/References:

Bolton, W. "Mechatronics", Pearson Education, 4th Edition, 2008.
'Mechatronics', HMT Ltd., Tata McGraw Hill Publication Co. Ltd., New Delhi, 5th Edition, 2009.
Michael B. Histand and David G. Alciatore, "Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 2005.
Ramachandran, K.P., Vijayaraghavan, G.K.and Bala Sundaram, M.S. "Mechatronics: Integrated Mechanical Electronic System" Wiley India Pvt Ltd.
Bradley D. A., Dawson D., Buru N.C. and. Loader A.J, "Mechatronics", Chapman and Hall, 1993.
Dan Necsulesu, "Mechatronics", Pearson Education Asia, 2002 (Indian Reprint).
Lawrence J. Kamm, "Understanding Electro – Mechanical Engineering", An Introduction to Mechatronics, Prentice – Hall of India Pvt., Ltd., 2000.
Nitaigour Premchand Mahadik, "Mechatronics", Tata McGraw-Hill publishing Company Ltd, 2003.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE356	INDUSTRIAL ELECTRONICS	L-T-P-C: 3-0-0-3

Course Objective:

To acquaint with advanced industrial circuits and its applications.

Course Outcomes:

CO1: Understanding of fundamental principles of transducers, sensors and actuators.
CO2: Ability to develop PLC programs for simple industrial applications.
CO3: Familiarity with the processes involved in industrial automation, industrial heating and basic working of high voltage equipment.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3	2	1		2									
CO3	3													

Syllabus:

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.
Virtual lab platforms can be utilized for classroom teaching.

Textbook:
Charles A. Schuler and William.L. Mc. Namee, "Industrial Electronics and Robotics: International McGraw Hill, 1986.

References:
S.K. Bhattacharya and S. Chatterjee, "Industrial Electronics & Control", Tata Mc Graw Hill, 2003.
Terry. L.M. Bartell, "Industrial Electronics", Delmer Publishers, 1997
Thomas E. Kissell, "Industrial Electronics", 2002

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE357	EMBEDDED SYSTEMS DESIGN	L-T-P-C: 3-0-0-3

Pre-requisites: Microcontrollers and Applications

Course Objective:

To introduce to concepts of embedded systems and familiarize with related software.

Course Outcomes:

CO1: Knowledge on hardware and software architectures in embedded systems.
CO2: Ability to identify interfacing issues in embedded systems.
CO3: Ability to analyze the need of RTOS in embedded systems.
CO4: Ability to develop an embedded system based real time application.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	1	-	-	-	-	-	-	-	-	-	-	2	-
CO4	3	2	2	1	2	-	-	-	-	-	-	-	2	1

Syllabus

Unit 1
Embedded processors: Introduction to Microprocessors – Microcontrollers – Digital Signal Processors – Embedded processors – ARM Cortex M Processor – Architecture – ARM Instruction – Addressing modes.

Unit 2
NXP LPC 17xx series Microcontroller: Architecture – Peripherals overview – Input/Output ports –Timer – ADC – DAC – PWM. Serial Protocols – USART, I2C, CAN, Fire Wire, USB, Parallel Protocols, PCI Bus, ARM Bus, Wireless Protocols, IrDA, Bluetooth, IEEE 802.11

Unit3
Real time Embedded Systems: Real Time Operating Systems (RTOS)- Task – Task states – Task Management – Scheduler – Inter task Communication and Synchronization – Exceptions and Interrupts – Time Management – Memory management – I/O subsystems, Commercial RTOS – uC/OS II. Lab Practice: Real time application development using ARM based development platform.

Text Books:
Joseph Liu, The definitive guide to the ARM Cortex – M3, II edition, Newnes, 2009.
Qing Li and Carolyn, Real time concepts for embedded systems, CMP books, 2003.
Steve Furber, ARM System-on-Chip architecture, II edition, Addison Wesley, 2000.
Jean J. Labrosse, Micro /OS-II, The real time kernel, II edition, CMP books, 1998.

References:
NXP LPC 17xx, datasheet
mBed NXP online compiler documentation

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE358	ADVANCED MICROCONTROLLERS	L-T-P-C: 3-0-0-3

Pre-requisites: Microcontrollers and Applications

Course Objective:

To acquire the knowledge of implementation of real world applications through programming of advanced microcontrollers.

Course Outcomes:

CO1: Understanding of concepts of advanced microcontrollers.
CO2: Ability to program dsPIC/MSP430 microcontroller.
CO3: Design dsPIC/MSP430 based system for various applications.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	1	2	-	-	-	-	-	-	-	-	-
CO3	3	2	1	1	-	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1:
dsPIC 30F series DSC: Introduction to 16 bit microcontrollers- dsPIC 30F DSC – CPU, Data memory, Program Memory- Instruction set- Programming in Assembly and C. Lab practice: Familiarisation of dsPIC programming environment.

Unit 2:
Peripherals of dsPIC 30F DSC: I/O Ports, Timers, Input Capture, Output Compare, Motor Control PWM, QEI, 10 bit A/D Converter, UART, CAN Module. Lab practice: Programming and simulation of dsPIC peripherals using dsPIC programming environment.

Unit 3:
MSP430 and peripherals: MSP430f2274- MSP430X22X2 device pin out, DA Package, Functional Block diagram description, Inputs, Outputs, Timers, ADC.

Textbooks/References:
dsPIC30F Family Reference manual, Microchip 2008
dsPIC30F Programmer's Reference manual, Microchip 2008
Chris Nagy, "Embedded System Design using the TI MSP 430 series", First Edition. Newnes, 2003
Digital signal Processing Implementations using DSP microprocessors with examples from TMS320C54XX, by Avtar Singh,and S.Srinivasan
Digital Signal Processors by B.Venkat Ramani and Bhaskar
MSP430f2274, Reference Manual, Texas Instruments.- www.ti.com

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE359	DIGITAL SIGNAL PROCESSORS	L-T-P-C: 3-0-0-3

Pre-requisites: Microcontrollers and Applications, Digital Signal Processing

Course objective:

To be aware about digital signal processors and implement signal processing algorithms for real time applications

Course Outcomes:

CO1: Knowledge on architecture of Digital Signal Processors (DSPs)
CO2: Ability to analyse instruction set and addressing modes of DSPs
CO3: Ability to implement basic signal processing operations
CO4: Ability to develop real time signal processing applications

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	1	-	1	-	-	-	-	-	-	-	-	-
CO4	3	2	2	-	1	-	-	-	-	-	-	-	1	1

Syllabus:

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
Programming using TMS320C67xx : Assembly language and C programming – Integrated Development Environment - Code Composer Studio and Visual DSP++ - Application development.
Unit 3
Blackfin Processor: Blackfin 5xx DSP – Architecture- Instruction set – Addressing modes
Lab Practice: Programming and Simulation of C6000 DSP.

Textbook/References:
Texas Instruments, C6000 Online reference Manual Available Online, "http://processors.wiki.ti.com/index.php/Category:C6000"
Woon Seng Gan and Sen M Kuo, "Embedded Signal Processing with the Micro Signal Architecture", IEEE Computer Society Press, 2008.
Dahnoun N, "Digital signal processing implementation using the TMS320C6000 DSP platform", Prentice Hall, 2000.
Andy Bateman, Iain Paterson-Stephens, "The DSP Handbook, Algorithms, Applications and Design Techniques", Prentice-Hall, 2002.
www.ti.com and www.analog.com .

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE360	VLSI SYSTEM DESIGN	L-T-P-C: 3-0-0-3

Pre-requisites: Digital Systems

Course Objective:

To expose to complete digital system design using VLSI technology.

Course Outcomes:

CO1: Ability to model basic digital circuits using Hardware Description Language.
CO2: Ability to design of digital systems with different levels of abstraction using HDL.
CO3: Ability to analyze the design flow of logic synthesis using HDL.
CO4: Ability to comprehend the different types of FPGA architecture and its components.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2		3									
CO2	3	3	3	2	3									
CO3	3	3	3	2	3									
CO4	3	1												

Syllabus

Unit 1
Introduction to digital design: Implementation of Combinational & sequential circuits, simple PLDs, CPLDs, ASIC/FPGA design flow, HDL, Role of HDL
Introduction to Verilog HDL: Overview of Digital Design with Verilog HDL – Hierarchical modeling Concepts - Basic concepts – Modules and Ports – Verilog Constructs

Unit 2
Overview of different levels of abstractions: Gate Level Modeling - Dataflow Modeling - Behavioral Modeling - Switch Level Modeling
Logic Synthesis with Verilog HDL: Introduction to logic synthesis - impact of logic synthesis - Verilog HDL constructs and operators for logic synthesis - synthesis design flow – Concepts of verification – Implementation of simple applications using Xilinx ISE Webpack.

Unit 3
Introduction to FPGA Fabrics: Implementation technology - PLDs, custom chips, standard cell and gate arrays - FPGA architectures - SRAM based FPGAs - Permanently programmed FPGAs - Circuit design of FPGA fabrics - Architecture of FPGA Fabrics - Logic Implementation of FPGA - Physical design for FPGAs

Textbooks:
Samir Palnitkar, "Verilog HDL", Prentice Hall India Pvt. Ltd., 2003
Wayne Wolf, "FPGA-Based System Design", Prentice Hall India Pvt. Ltd., 2004

References:
Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital logic with Verilog Design", Tata McGraw Hill Publishing Company Limited, Special Indian Edition, 2007.

Stephen M.Trimberger. "Field-Programmable Gate Array Technology, Springer, 1994.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

AUTOMOTIVE SYSTEMS

19EEE431	ELECTRIC VEHICLES	L-T-P-C: 3-0-0-3

Pre-requisites: Electrical Machines, Power Electronics, Electric Drives and Control

Course Objectives:

To impart knowledge on electric drives, energy storage, energy management and vehicular communication in electric vehicles.

Course Outcomes:

CO1: Understanding of electric vehicle drives, energy storage, energy management systems and vehicular communication system.
CO2: Ability to apply AC, DC, permanent magnet electric drive concepts in electric vehicles, develop charging systems and implement regeneration.
CO3: Exposure to vehicular communication protocols.
CO4: Ability to design electric drive systems for different topologies.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	1	-	1	-	-	-	-	-	-	-	1	1
CO4	3	2	2	-	1								1	1

Syllabus

Unit 1
xEV:- Introduction to xEV's – BEV, HEV, PEV, FCEV- Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, xEV Drive Trains:- Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains.
Electric Propulsion systems: EV consideration, DC motor drives, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives, Sizing of Electric Machine for EVs and HEVs.

Unit 2
Energy Storage and power electronics for battery charging and grid interface**:**Energy Storage Requirements in (Hybrid and) Electric Vehicles:- Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices. EV and PHEV Battery Charging: Grid and Renewable Energy Interface, Regenerative braking.
Energy Management Strategies: classification, comparison and implementation issues of EMS. On-board power electronic battery Management systems.
Design of Electric and Hybrid Electric vehicle: Parallel Hybrid Electric Drive Train Design: Control strategies of parallel hybrid drive train, design of engine power capacity, design of electric motor drive capacity, transmission design, and energy storage design.

Unit 3

Vehicular Networks: Cross-System Functions, Requirements For Bus Systems, Classification Of Bus Systems, Application In The Vehicle, Coupling Of Networks, Examples Of Networked Vehicles; Bus Systems: CAN Bus, CAN-FD, LIN Bus, MOST Bus Bluetooth,Flex Ray, Diagnostic Interfaces: Implementation Of Body Electronics Functionalities Using Controllers. Control Systems for the HEV and EVs:, On-Board Diagnostics (OBD), Introduction to autonomous driving.

Textbook/References:

M. Ehsani, Y. Gao, S. Gay and Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2015

Iqbal Hussain, "Electric & Hybrid Vechicles – Design Fundamentals", Second Edition, CRC Press, 2011.

Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer, 2013.

James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Paul, A., Chilamkurti, N., Daniel, A. and Rho, S. Intelligent Vehicular Networks and Communications. Elsevier Science and Technology Books, Inc. 2017

Wai Chen,"Vehicular Communications and Networks: Architectures, Protocols, Operation and Deployment", Elsevier Science and Technology Books 2015

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE432	VEHICULAR NETWORKS AND COMMUNICATION	L-T-P-C: 3-0-0-3

Course Objectives

To expose to the communication requirements and capabilities of automobiles and various protocols, standards and applications for in-vehicle, V2I and V2V communications.

Course Outcome

CO1: Knowledge on communication technologies, protocols and standards of automotive systems
CO2: Familiarization with vehicular network models and functions
CO3: Ability to analyze the protocols and standards for V2V and V2I communication

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	2	-	1	-	-	-	-	-	-	-	3	1

Syllabus

Unit 1
Introduction to vehicular communications- Overview on transportation networks, Evolution of transportation models, Vehicular network standardization, Vehicular communication technologies,Vehicular network (VN) model-Cluster-based vehicular networks, Vehicle platooning, Vehicular cloud, Hybrid sensor–vehicular networks, Information distribution, Internet of Vehicles,

Unit 2
Vehicular Networks: Cross-System Functions, Requirements for Bus Systems, Classification of Bus Systems, Application in The Vehicle, Coupling of Networks, Examples of Networked Vehicles; Bus Systems: CAN Bus, CAN-FD, LIN Bus, MOST Bus Bluetooth, Flex Ray,

Unit 3
Vehicular Communications: Intelligent Transportation Systems: IEEE 802.11p-ITS-IVC: Inter- Vehicle Communications- Mobile Wirless Communications and Networks- Architecture Layers-Communication Regime.V2V, V2I-VANET-WAVE; DSRC.

TEXT BOOKS/REFERENCES:
Dominique Paret, "Multiplexed Networks for Embedded Systems: CAN, LIN, FlexRay, Safe-by-Wire", Wiley,2007.
Dominique Paret, "FlexRay and its Applications: Real Time Multiplexed Networks", Second Edition, Wiley,2012.
Popescu-Zeletin R, Radusch I and Rigani M.A, "Vehicular-2-X Communication", Springer,2010.
Xiang W, "Wireless Access in Vehicular Environments Technology", Springer, 2015.
Laun T.H, Shen X. (Sherman) and Bai F, "Enabling Content Distribution in Vehicular AdHoc Networks", Springer, 2014.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE433	E-MOBILITY BUSINESS AND POLICIES	L-T-P-C: 3-0-0-3

Course Objectives

To impart knowledge on the need of policies for Electric Vehicle charging and infrastructure requirements.

Course Outcome

CO1: Understanding the models used in public transportation system
CO2: Familiarize the concept of shared mobility services, advantages and monitory benefits
CO3: Introduce to the infrastructure requirements for electric vehicle charging
CO4: Ability to comprehend, design and develop policies for electric vehicle charging

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	3	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	2	-	-	-	-	-	-	-	-
CO4	3	-	3	-	2	-	-	-	-	-	-	-	-	-

Syllabus

Unit 1
Introduction to India's passenger mobility sector- Current State of India's Public Transport System, Public Transport: Efficiently and Affordably Mobilizing Cities, Opportunities To Maintain And Ideally Increase The Utilization Of Public Transport In India, Expanding India's Definition Of Public Transport Through Data And New Business Models.

Unit 2
India's Path Forward In Public Transport, Sharing and Mobility Services: Unlocking Economic Electrification- the business case for shared, electric mobility services, Examples of Shared Mobility Services Active In Today's Global Marketplace- Ride-Hailing Services: Pooled Ride-Hailing Services: Vehicle Sharing: Peer-To-Peer Vehicle Sharing: Fixed-Route Commuter Services: Incentives to promote electric mobility and sharing: Parking and pick-up benefits: Road toll and road tax discount or exemption: Licensing and registration benefits.

Unit 3
Congestion pricing: Low-emission zones: EV Charging Infrastructure: Powering EVs and Recharging 4 India's Electricity Sector: Considerations and Implications For India's EV Charging Infrastructure Deployment Standards: EV standards-IEEE, IEC and SAE, Basics of EV charging, EV charging standards and infrastructure, Smart Parks, V2G, G2V, V2B, V2H, renewable energy integration to EV charging infrastructure.

TEXT BOOK/REFERENCES:
Emadi, A. (Ed.), Miller, J., Ehsani, M. (2003). Vehicular Electric Power Systems. Boca Raton: CRC Press.
Husain, I. (2010). Electric and Hybrid Vehicles. Boca Raton: CRC Press.
Larminie, James, and John Lowry. Electric Vehicle Technology Explained. John Wiley and Sons, 2012.
Tariq Muneer and Irene Illescas García, 1 - The automobile, In Electric Vehicles: Prospects and Challenges, Elsevier, 2017, Pages 1-91.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE434	AUTOMOTIVE ELECTRONICS	L-T-P-C: 3-0-0-3

Pre-requisites: Circuits Analysis, Control Systems

Course Objectives

To introduce the electrical, electronics and communication networks and components used in Electric Vehicles

Course Outcome

CO1: Understanding of the basic principles of electronic systems, power train control systems, electrical and communication systems in electric vehicles.
CO2: Ability to analyze the performance of various control systems, engine management and electrical networks and components in electric vehicles
CO3: Ability to design electronic systems, power train, engine management, battery and communication systems for electric vehicles.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	1	-	1	-	-	-	-	-	-	-	-	-
CO3	3	2	3	-	-	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Introduction to Electronic systems in Automotives – Sensors and Actuators for body electronics, power train and chassis systems. Body electronics domain- Automotive alarms, Lighting, Central locking and electric windows, Climatic Control, Driver information, Parking, etc.

Unit 2
Power train and chassis control domain – Engine management, Transmission control, ABS, ESP, Traction Control, Active Suspension, passive safety, Adaptive Cruise Control, etc. Hardware implementation example of simple automotive systems using Sensors, Controller, Actuators etc.

Unit 3
Battery- types and maintenance, Alternators in vehicles, Starting motor systems, Electrical circuits and wiring in vehicles, vehicle network and communication buses – Digital engine control systems, Introduction to automotive controllers, On-Board Diagnostics (OBD).

TEXT BOOKS/REFERENCES:
Bosch,"Automotive Electrics and Automotive Electronics. System and components, Networking and Hybrid drive", Fifth edition, Springer view 2014.
Najamuz Zaman, "Automotive Electronics Design Fundamental'' First edition, Springer 2015.
Hillier's, "Fundamentals of Motor Vehicle Technology on Chassis and Body Electronics", Fifth Edition, Nelson Thrones, 2007.
William B. Ribbens, "Understanding Automotive Electronics" Sixth Edition, Elsevier Newnes, 2002.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE435	AUTOMOTIVE CONTROL SYSTEMS	L-T-P-C: 3-0-0-3

Pre-requisites: Control Systems

Course Objectives:

To impart knowledge on modeling and analysis of vehicle dynamics and design controllers for automotive systems.

Course Outcomes

CO1: Understanding of vehicle dynamics and road-driver models. (BTL-2)
CO2: Ability to diagnosis the vehicle faults using fault models.(BTL-3)
CO3: Ability to analyze the ABS control systems.(BTL-4)
CO4: Ability to develop a complete driver model with path, road surface and wind strength.(BTL-5)

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	-	2	-	-	-	-	-	-	-	-	-
CO3	3	2	1	1	2	-	-	-	-	-	-	-	-	-
CO4	3	1	3	2	2	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Overview of Control System: Modeling, Time/Frequency Response Analysis And Stability Analysis: PID, State Variable Analysis.
Model Based Diagnosis: Characteristics, Faults, Fault Modeling, Principles Of Model Based Diagnostics- Residual Generator Design, Residual Evaluation, Engineering Of Diagnosis Systems, Application Example.

Unit 2
Vehicle Control Systems: ABS Control Systems- Torque Balance At Vehicle- Road Contact, Control Cycles Of The ABS System, ABS Cycle Detection; Control Of Yaw Dynamics- Deviation Of Simplified Control Law, Derivation Of Reference Values.

Unit 3
Road and Driver Models: Road Model- Requirements of The Road Model, Definition of The Course Path, Road Surface and Wind Strength; PID Driver Model; Hybrid Driver Model – Vehicle Control Tasks, Characteristics of Human as A Controller, Information Handling, Complete Driver Model.
Simulation/case studies on relevant topics.

TEXT BOOKS/REFERENCES
Kiencke, Uwe and Nielsen, Lars, "Automotive Control Systems for Engine, Driveline and Vehicle", Springer, 2005
I.J Nagrath and M.Gopal, "Control Systems Engineering", Wiley Eastern Limited, New Delhi, 2008.
M.Gopal, "Modern Control System Theory", New Age International,2005.
Katsuhiko Ogata, "Modern Control Engineering", Fifth Edition, Prentice Hall, 2010.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

19EEE436	VEHICLE DYNAMICS AND CONTROL	L-T-P-C: 3-0-0-3

Pre-requisites: Control Systems

Course Objectives

To understand the concept of vehicle dynamics and analyze the parameters for adaptive vehicular control

Course Outcome

CO1: Understanding of concepts in vehicle dynamics and control.
CO2: Knowledge on control system architecture and adaptive vehicular control.
CO3: Ability to design and develop controllers for braking system in Electric vehicle.
CO4: Ability to analyze the electronic stability control in Electric Vehicles.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	3	1	2	-	-	-	-	-	-	-	1	1
CO4	3	2	3	1	2	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Introduction To Driver Assistance Systems, Active Stability Control, Ride Quality, Technologies For Addressing Traffic Congestion, Emissions And Fuel Economy; Lateral Vehicle Dynamics: Kinematic Models, Dynamic Bicycle Model, From Body Fixed To Global Coordinates: Lateral Vehicle Control: State Feedback, Steady State Analysis: Understanding Steady State Comering, The Output Feedback Problem, Compensator Design With Look Ahead Measurement; Longitudinal Vehicle Dynamics: Longitudinal Vehicle Model, Driveline Dynamics, Mean Value Engine Models.

Unit 2
Longitudinal Vehicle Control: Introduction: Cruise Control, Control System Architecture, Adaptive Cruise Control, Individual Vehicle Stability and String Stability, String Stability with Constant Spacing, String Stability with Constant Time Gap, Controller for Transitional Maneuvers, Automated Highway Systems, Longitudinal Control for Vehicle Platoons, String Stability with Inter- Vehicle Communication, Adaptive Controller for Unknown Vehicle Parameters.

Unit 3
Electronics Stability Control: Vehicle Model, Control Design for Differential Braking Based Systems, Control Design for Steer-By-Wire System, Independent All Wheel Drive Torque Control: Active Automotive Suspensions: H2 Optimal Control, LQR Formulation for Active Suspension Design, Analysis of Trade-Offs Using Invariant Points, Performance of The Sky-Hook Damping Controller, Control with Hydraulic Actuators;
Lab Experiments Based on Simulation Tools.

TEXT BOOKS/REFERENCES:

Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", SAE International, 1992.
R. Rajamani, "Vehicle Dynamics and Control", Second Edition, Springer Verlag 2012.
Uwe Kiencke and Lars Nielsen, "Automotive Control Systems: For Engine Driveline, and Vehicle", Second edition, Springer, 2005.
John C Dixon, "Tyres, Suspension and handling", 2nd Revised Edition, SAE International, 1996.
Hans B. Pacejka, "Tyre and Vehicle Dynamics", Second Edition, Butterworth-Heinemann, 2006.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

COMPUTER ENGINEERING

19CSE330	INFORMATION TECHNOLOGY ESSENTIALS	L-T-P-C: 3-0-0-3

Course Objective:

To understand the concept of internet, networking principles and learn scripting languages to develop information system.

Course Outcomes:

CO1: Understand the concept of Internet, Networks and its working principles.
CO2: Learn scripting languages.
CO3: Understand various applications related to Information Technology.
CO4: Develop information system

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	3													
CO3	2	3	2	1										
CO4	2	3	3	1									2	1

Syllabus

Unit 1
Web essentials : Creating a Website – Working principle of a Website – Browser fundamentals – Authoring tools – Types of servers: Application Server – Web Server – Database Server; Scripting essentials : Need for Scripting languages – Types of scripting languages – Client side scripting – Server side scripting – PHP – Working principle of PHP – PHP Variables – Constants – Operators – Flow Control and Looping – Arrays – Strings – Functions – File Handling – PHP and MySQL – PHP and HTML – Cookies – Simple PHP scripts.

Unit 2
Networking essentials : Fundamental computer network concepts – Types of computer networks – – Network layers – TCP/IP model – Wireless Local Area Network – Ethernet – WiFi – Network Routing – Switching – Network components; Mobile communication essentials: Cell phone working fundamentals – Cell phone frequencies & channels – Digital cell phone components – Generations of cellular networks – Cell phone network technologies / architecture – Voice calls & SMS

Unit 3
Application essentials: Creation of simple interactive applications – Simple database applications – Multimedia applications – Design and development of information systems – Personal Information System – Information retrieval system – Social networking applications

Textbooks/References:

Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5" Third Edition, O'REILLY, 2014.
James F. Kurose, ―Computer Networking: A Top-Down Approach, Sixth Edition, Pearson, 2012.
Gottapu Sasibhushana Rao, "Mobile Cellular Communication", Pearson, 2012.
R. Kelly Rainer, Casey G. Cegielski, Brad Prince, Introduction to Information Systems, Fifth Edition, Wiley Publication, 2014.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE331	CRYPTOGRAPHY	L-T-P-C: 3-0-0-3

Course Objective

To learn core concepts of cryptography techniques and various algorithms like RSA, DES and AES.

Course Outcomes:

CO1: Understand classical cryptography techniques and apply crypto analysis
CO2: Analyze measures for securing cryptosystem
CO3: Apply and analyze operations on Feistel and non-Feistel structures
CO4: Perform asymmetric encryption

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3			1	3								3	
CO2	3	3	2		3								3	
CO3	3	3	3		3								3	2
CO4	3	3	3	3	3								3	3

Syllabus

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.

Textbooks/References:
Padmanabhan T R, Shyamala C K and Harini N, "Cryptography and Security", First Edition, Wiley Publications, 2011.
Stallings W, "Cryptography and Network Security", Third Edition, Pearson Education Asia, Prentice Hall, 2000.
Forouzan B A, "Cryptography and Network Security", Special Indian Edition, Tata McGraw Hill, 2007

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE348	MACHINE LEARNING	L-T-P-C: 3-0-0-3

Pre-requisites: Probability and Statistics, Matrix Algebra

Course Objectives:

To introduce the fundamental concepts of various optimization techniques and machine learning algorithms and expose to various applications of machine leaning.

Course Outcomes:

CO1: Understanding of different approaches and techniques in machine learning.
CO2: Ability to apply supervised and unsupervised machine learning algorithms.
CO3: Ability to develop programming skills to build intelligent, adaptive artifacts.
CO4: Ability to develop machine learning techniques to solve real world problems.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1		-	-	-	-	-	-	-	-	-	-	-
CO2	3	1	2	-	-	-	-	-	-	-	-	-	-	-
CO3	3	1	2	-	-	-	-	-	-	-	-	-		
CO4	3	1	2	-	-	-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Refresher - Random variables, probability mass function, conditional probability chain rule, Expectation, variation, co-variance, KL-divergence, Normal distribution, Bernouli distribution, Bayes rule.

Unit 2
Supervised learning:
Naive Bayes rule, Hypothesis and P-Value, Introduction to T-SNE. Multi class classification - K-NN, local outlier factor, k distance, impact of scale and column standardization, Bias-variance tradeoff, Features, Handling categorical and numerical features. Support vector machines, Application of SVM; Kernals - polynomial, RBF, Domain specific, Decision trees: Building decision trees, train and runtime complexities, Regression using decision trees, Application of decision trees. Performance measurements of models: Accuracy, Confusion matrix, F1-score, ROC curve and AOC, Log loss, Mean absolution deviation (MAD), R-squared -coefficent of determination.

Unit 3
Unsupervised learning- K-means, Expectation-Maximization; Dimensionality reduction: Principal Component Analysis for data dimensionality reduction and Visualization; Neural Networks: Basics-Perceptron,Exponential Family,Generalized Linear Models. Training, Evaluation metrics. Mixture of Gaussians. Expectation Maximization.

Textbook/ References:
Christopher Bishop"Pattern Recognition and Machine Learning" Springer-Verlag New York, Edition 1, 2009.
Tom mitchell, "Machine Learning", McGraw-Hill, 1997
Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Prentice Hall.
Richard O. Duda, Peter E. Hart, David G. Stork, "Pattern Classification", Wiley publishers, Second Edition, 2000.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE349	VIRTUAL REALITY	L-T-P-C: 3-0-0-3

Pre-requisites: Computer Programming I & II

Course Objectives:

To understand virtual reality concepts and study of relevant mathematical modelling and software.

Course Outcomes:

CO1: Understand geometric modelling and Virtual environment
CO2: Study about Virtual Hardware and Software
CO3: Develop Virtual Reality applications.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1			3								3	
CO2	3			1	3								3	
CO3	3	1	3	1	3								3	1

Syllabus

Unit 1
Introduction to Virtual Reality - Virtual Reality and Virtual Environment: Introduction, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark 3D Computer Graphics: Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modelling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism-Stereographic image.

Unit 2
Geometric Modelling - Geometric Modelling: Introduction, From 2D to 3D, 3D space curves, 3D boundary representation Geometrical Transformations: Introduction, Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems. Virtual Environment - Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Non-linear interpolation, the animation of objects, linear and non-linear translation, shape & object inbetweening, free from deformation, particle system.

Unit 3
Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft. VR Hardware and Software - Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modelling virtual world, Physical simulation, VR_ toolkits, Introduction to VRM.

Text Books/References:

John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.
Anand R., "Augmented and Virtual Reality", Khanna Publishing House, Delhi.
Adams, "Visualizations of Virtual Reality", Tata McGraw Hill, 2000.
Grigore C. Burdea, Philippe Coiffet , "Virtual Reality Technology", Wiley Inter Science, 2™ Edition, 2006.
William R. Sherman, Alan B. Craig, "Understanding Virtual Reality: Interface, Application and Design", Morgan Kaufmann, 2008.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE350	INTERNET OF THINGS	L-T-P-C: 3-0-0-3

Course Objective:

To understand the basics of IoT devices and its interfacing.

Course Outcomes:

CO1: Knowledge on internet of things and its hardware & software components
CO2: Ability to interface I/O devices, sensors and communication modules
CO3: Ability to remotely monitor data and control devices
CO4: Ability to develop real life IoT based projects

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3	1												
CO3	3	2			1									
CO4	3	2	2	1	2								1	1

Syllabus

Unit 1
Introduction to IOT: Architectural Overview, Design principles & needed capabilities, IOT applications, sensing, actuation, basics of networking, M2M and IOT technology fundamentals-devices and gateways, datamanagement, business processes in IOT, everything as a service(XaaS), role of cloud in IOT, Security aspects in IOT.

Unit 2
Elements of IOT: Hardware Components- computing (Arduino, Rasperry pi), communication, sensing, actuation, I/O interfaces. Software components- Programming API's (using python/Node.js/arduino) for communication protocols- MQTT,ZigBee, Bluetooth, CoAP, UDP, TCP.

Unit 3
Solution framework for IOT applications- implementation of device integration, data acquisition and integration, device data storage- unstructured data storage on cloud/local server, authentication, authorization of devices, Case studies

Text Books/ References:

Vijay madisetti, Arshdeep Bahga, Internet of Things, "A Hands-on approach". University Press.
Dr.SRN Reddy, Rachit Thukral and manasi Mishra, "Introduction to Internet of Things: A Practical Approach", ETI Labs.
Pethuru raj and Anupama C Raman, "The Internet of things: Enabling Technologies, Platforms, and use cases" CRC Press.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE362	FUNDAMENTALS OF SOFT COMPUTING	L-T-P-C: 3-0-0-3

Pre-requisites: Optimization Techniques

Course Objective:

To impart knowledge on theory and implementation of algorithms for various soft computing methods such as Neural Networks, Fuzzy Logic and Evolutionary Computing.

Course Outcomes:

CO1: Understanding of the logics of different soft computing techniques.
CO2: Ability to solve engineering problems using soft computing techniques.
CO3: Understanding of hybrid approach to solve engineering problems.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3	2	2	1	2									
CO3	3	1	2											

Syllabus

Unit 1
Introduction: Need for soft computing methods. Artificial Neural Networks: Different architectures:- single layer & multi-layer Perceptron network, ADALINE, MADALINE. Learning methods and rules: delta rule and Hebb rule, supervised, unsupervised and hybrid learning, Back Propagation Algorithm, competitive learning: Kohenon Self Organizing networks, associative memory neural networks: Hopfield networks.

Unit 2
Fuzzy set theory: basic concepts, fuzzy set operators, membership functions, fuzzy relations, fuzzy measures, rule based system and fuzzy reasoning. Fuzzification and defuzzification methods, fuzzy inference systems:-Mamdani, Sugeno, and Tsukamoto, graphical techniques of inference. Fuzzy classification:-fuzzy C-means clustering, Fuzzy associative memories, applications, fuzzy decision making algorithm.

Unit 3
Evolutionary Computation: Introduction, Survival of the Fittest, Fitness Computation, Cross over, Mutation, Reproduction. Hybrid Approach:-GA based fuzzy model identification, Fuzzy logic controlled GA, neuro-genetic hybrids & fuzzy-genetic hybrids. Neuro fuzzy modeling, Adaptive neuro fuzzy inference systems. Case Studies on applications of soft computing.

Textbooks/References:
Laurene Fausett,"Fundamentals of neural networks, Architectures, Algorithms, and Applications", Pearson Education, 2002.
Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Wiley India Private Limited, 2010.
G. A Vijayalakshmi Pai & S. Rajashekharan "Neural Network, Fuzzy Logic, Genetic Algorithms Synthesis & Applications", PH India,2003.
Jang.J.S.R, sun.C.T, Mizutani.E, "Neuro fuzzy and Soft Computing" ,Prentice Hall of India Private Limited,2002.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE363	ARTIFICIAL INTELLIGENCE	L-T-P-C: 3-0-0-3

Pre-requites: Matrix Algebra, Probability and Statistics

Course Objective:

To learn concepts of Artificial Intelligence and develop programs for self learning agents.

Course Outcomes:

CO1: Build intelligent agents and search and games
CO2: Solve AI problems through programming with python
CO3: Comprehend optimization and inference algorithms for model learning
CO4: Design and develop programs for an agent to learn and act in a structured environment

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				3								3	
CO2	3	3			3								3	
CO3	3	2	2		3								3	3
CO4	3	3	3	3	3								3	3

Syllabus

Unit 1
Introduction: Overview and Historical Perspective, Turing test, Physical Symbol Systems and the scope of Symbolic AI, Agents. State Space Search: Depth First Search, Breadth First Search, DFID. Heuristic Search: Best First Search, Hill Climbing, Beam Search, Tabu Search.

Unit 2
Randomized Search: Simulated Annealing, Genetic Algorithms, Ant Colony Optimization. Finding Optimal Paths: Branch and Bound, A*, IDA*, Divide and Conquer approaches, Beam Stack Search. Problem Decomposition: Goal Trees, AO*, Rule Based Systems, Rete Net. Game Playing: Minimax Algorithm, AlphaBeta Algorithm, SSS*.

Unit 3
Planning and Constraint Satisfaction: Domains, Forward and Backward Search, Goal Stack Planning, Plan Space Planning, Graphplan, Constraint Propagation. Logic and Inferences: Propositional Logic, First Order Logic, Soundness and Completeness, Forward and Backward chaining.

Textbook:
Deepak Khemani. A First Course in Artificial Intelligence, McGraw Hill Education (India), 2013.

References:

Stefan Edelkamp and Stefan Schroedl. Heuristic Search: Theory and Applications, Morgan Kaufmann, 2011.
John Haugeland, Artificial Intelligence: The Very Idea, A Bradford Book, The MIT Press, 1985
Pamela McCorduck, Machines Who Think: A Personal Inquiry into the History and Prospects of Artificial Intelligence, A K Peters/CRC Press; 2nd Edition, 2004.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE364	BIG DATA ANALYTICS	L-T-P-C: 3-0-0-3

Pre-requisites: Data Structures and Algorithms

Course Objective:

To introduce to the core concepts of handling and analyzing big data and different large scale data storage technologies and data streaming platforms.

Course Outcomes:

CO1: Understanding of terminologies and core concepts of big data problems and applications.
CO2: Understanding of common data structure frameworks.
CO3: Exposure to large scale data storage technologies and big data streaming platforms

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-				-	-	-	-	-	-	-	-	-
CO2	3	1				-	-	-	-	-	-	-	-	-
CO3	3	1				-	-	-	-	-	-	-	1	1

Syllabus

Unit 1
Introduction to bigdata, Challenges with Big data, Big data enabling technologies, Hadoop stack for bigdata, RDBMS vs Hadoop, Hadoop distributed file system (HDFS), Hadoop MapReduce 1.0, Hadoop MapReduce 2.0 (Part-I), YARN architecture, MapReduce Examples, Parallel Programming with spark, Introduction to Spark, Spark Built-in-Libraries, Design of Key-Value Stores, Pig on Hadoop.

Unit 2
Data Placement Strategies, CAP Theorem, Consistency Solutions, Design of Zookeeper, CRUD operations, CQL (Cassandra Query Language), Design of HBase, Spark Streaming and Sliding Window Analytics, Spark Steaming, Sliding window Analytics, Introduction to Kafka, Big Data machine learning, Machine learning Algorithm K-means using Map Reduce for Big Data Analytics, Parallel K-means using Map Reduce on Big Data Cluster Analysis.

Unit 3
Decision Trees for Big Data Analytics, Big Data Predictive Analytics, Parameter Servers, PageRarnk Algorithm in Big Data, Spark GraphX and Graph Analytics, Case study.

Text Book:
Seema Acharya, Subhashini Chellappan , "Big Data and Analytics", Wiley Publication, 2015.

References:
Judith Hurwitz,Alan Nugent, Dr.Fern Halper, Marcia Kaufman , "Big Data for Dummies", John Wiley & Sons, Inc., 2013.
Tom White, "Hadoop: The Definitive Guide", O'Reilly Publications, 2011.
Kyle Banker, "Mongo DB in Action", Manning Publications Company, 2012.
Russell Bradberry, Eric Blow, "Practical Cassandra A developers Approach ", Pearson Education, 2014.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE365	COMPUTER ORGANIZATION AND DESIGN	L-T-P-C: 3-0-0-3

Pre-requisites: Computer Programming, Digital Systems

Course Objective:

To introduce the concepts of computer architecture and organization and methods to improve system performance.

Course Outcomes:

CO1: Understanding on architecture and performance metrics of a processor
CO2: Ability to analyze the instruction formats and addressing modes of the processor.
CO3: Ability to design the single cycle and pipelined data path of the processor
CO4: Exposure to issues related to cache and virtual memory

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-		-	-
CO2	3	1	-	-	-	-	-	-	-	-	-		-	-
CO3	3	2	3	1	-	-	-	-	-	-	-		-	-
CO4	3	2	1	2	-	-	-	-	-	-				

Syllabus

Unit 1
Basic digital system design including finite state machines, instruction set design and simple RISC assembly programming, quantitative evaluation of computer performance, circuits for integer and floating-point arithmetic, datapath and control-Logic Design Conventions, Building a Datapath.

Unit 2
A Simple Implementation Scheme, A Multicycle Implementation, Exceptions, Microprogramming: Simplifying Control Design, An Introduction to Digital Design Using a Hardware Design Language, micro-programming, pipelining, Basics of Caches, measuring and improving cache performance.

Unit 3
Storage hierarchy and virtual memory- input/output, different forms of parallelism including instruction level parallelism, data-level parallelism using both vectors and message-passing multi-processors, and thread-level parallelism using shared memory multiprocessors. Basic cache coherence and synchronization.

Text Book/References:
David A Patterson and John L Hennessy, "Computer Organization and Design: The Hardware Software Interface" Morgan publishers (imprint of Elsevier), Thrid edition, 2005.
Patterson, David A and J L Hennessy, "Computer Organisation & Design, The Hardware/ Software Interface (ARM Edition)", Morgan Kaufmann, Fourth Edition, 2010.
Hennnessy and Patterson, "Computer Architecture: A Quantitative Approach", Elsevier, Fifth Edition, 2011.
W Stallings, "Computer Organisation & Architecture: Designing for Performance", Pearson, Eighth Edition, 2010
V.CarlHamacher, Zvonko G. Varanesic and Safat G. Zaky, "Computer Organisation", Fifth Edition, McGraw-Hill Education (India), 2011.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE366	CYBER SECURITY	L-T-P-C: 3-0-0-3

Pre-requisites: IT Essentials, Computer Programming I

Course Objective

Demonstrate a breadth of knowledge in the many topics of Computer Security, and understand its relevance and potential for an ever increasing number of applications.

Course Outcomes:

CO1: Understand the fundamentals concepts of computer security applied to different components of computing systems.
CO2: Identify the basic cryptographic techniques using existing software in maintain information security.
CO3: Describe how malicious attacks, threats, and protocols for security vulnerabilities impact a systems infrastructure.
CO4: Demonstrate a breadth of knowledge in the many topics of Computer Security, and understand its relevance and potential for an ever-increasing number of applications.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				3								3	
CO2	3	3	2		3								3	
CO3	3	3	2	2	3								3	2
CO4	3		3	2	3								3	3

Syllabus

Unit 1
Basics of Computer Security: Overview - Definition of terms - Security goals - Shortcomings - Attack and defense - Encryption and Cryptography: Ciphers and codes - Public key algorithms - Key distribution - Digital signatures - Pretty good privacy

Unit 2
Authentication and Key Exchange Protocols: Directory authentication service - Diffie-Hellman key exchange – Kerberos -Software Security: Malicious code - Worms - Intruders - Error detection and correction - OS protection policies - Trusted Systems: Memory protection - Access control matrix - User authentication

Unit 3
Security models - Disaster recovery -Database Security: Integrity constraints - Multi-phase commit protocols - Networks Security: Threats in networks - DS authentication -Web and Electronic Commerce: Threats on the web - Secure socket layer - Client-side certificates - Applet security model.

Textbooks/References:
Stallings William, Cryptography and Network Security: Principles and Practice, 6th Edition, Pearson/Prentice-Hall, 2013.
Forouzan B A, "Cryptography and Network Security", Special Indian Edition, Tata McGraw Hill, 2007.

Padmanabhan TR, Shyamala C K, and Harini N, "Cryptography and Security", First Edition, Wiley India Publications, 2011.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE367	DIGITAL IMAGE PROCESSING	L-T-P-C: 3-0-0-3

Course Objective:

To learn mathematical formulations and processing techniques in 2D spatial and frequency domain for processing digital images.

Course Outcomes:

CO1: Knowledge on various concepts of 2D images and mathematical transforms necessary for image processing
CO2: Ability to apply image processing techniques in spatial and frequency domain
CO3: Ability to analyse filtering in spatial and frequency domain
CO4: Ability to develop software to understand image processing techniques with simple examples.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	1	-	-	-	-	-	-	-	-	-
CO2	3	2	2	-	1	-	-	-	-	-	-	-	-	-
CO3	3	2	2	-	1	-	-	-	-	-	-	-		
CO4	3	3	3	3	3	-	-	1	1	-	-	-	2	1

Syllabus

Unit 1
Digital image fundamentals-Image representation, basic relationship between pixels, elements of DIP system, elements of visual perception-simple image formation model, Brightness, contrast, hue, saturation, mach band effect, Colour image fundamentals-RGB, CMY, HIS models.

Unit 2
2D Transforms- DFT, its properties, Walsh transform, 15 Hadamard transform, Haar transform
Image enhancement- Spatial domain methods: point processing- intensity transformations, histogram processing, image subtraction, image averaging.
Frequency domain methods: low pass filtering, high pass filtering, homomorphic filter, Image restoration- Degradation model, Unconstraint restoration- Lagrange multiplier and constraint restoration.

Unit 3
Image segmentation-Classification of Image segmentation techniques, region approach, clustering techniques, Classification of edges, edge detection, Hough transform, active contour
Image compression Image compression standards- JPEG& MPEG, vector quantization, wavelet-based image compression.

Text Books:
Gonzalez Rafel C, Digital Image Processing, Pearson Education, 2009.
S Jayaraman, S Esakkirajan, T Veerakumar, Digital image processing, Tata Mc Graw Hill, 2015.

References:
Jain Anil K, Fundamentals of digital image processing, PHI,1988.
Kenneth R Castleman, Digital image processing, Pearson Education,2/e,2003

Pratt William K, Digital Image Processing, John Wiley,4/e,2007.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE368	INTRODUCTION TO COMPUTER NETWORKS	L-T-P-C: 3-0-0-3

Course Objective:

This course deals with the basics of networking, components and protocols

Course Outcomes:

CO1: Understand the basics of networking and their components.
CO2: Discuss various physical layer elements and apply network models to telephone network.
CO3: Analyse various design issues in data link layer.
CO4: Evaluate IP addressing techniques and discuss various multiple access control and routing protocols
CO5: Analyse elements of transport protocols and security aspects of computer networks.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3												1	1
CO3	3	1												
CO4	3												1	1
CO5	3	1											1	1

Syllabus

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

Text Books:

William Stallings, "Data and Computer Communications", 7th Edition, Pearson Education Asia, 2004.
Andrew S Tanenbaum, "Computer Network", Fourth Edition, Pearson Education, 2003

References:

James F Kurose and Keith W Ross, "Computer Networking – a Top Down Approach Featuring the Internet", Second Edition, Pearson Education, 2003
Berhouz A Forouzan, "Data Communication and Networking ", 3rd Edition, Tata McGraw Hill, 2004.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19CSE369 INTRODUCTION TO DATA STRUCTURES AND ALGORITHMS L-T-P-C: 3-0-0-3

Pre-requisites: Computer Programming

Course Objective:

To provide understanding of structure and implementation of the common data structures used in computer science and the concept of analyzing algorithms in terms of asymptotic notation.

Course Outcomes:

CO1: Understanding of basic data structures.
CO2: Ability to illustrate various operations on data structures.
CO3: Ability to analyze algorithms and check for correctness.
CO4: Ability to analyze application problems and formulate solutions using data structure.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2
CO1	3	1			-	-	-	-	-	-	-	-	-	-
CO2	3	1		-	1	-	-	-	-	-	-	-	-	-
CO3	3	1	1		1	-	-	-	-	-	-	-	-	-
CO4	3	1	1		1	-	-	-	-	-	-	-	-	-

Syllabus

Unit 1
Introduction: Overview of Data Structures – 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.

Text Books/References:

Goodrich M T and Tamassia R, "Data Structures and Algorithms in Java", Fifth edition, Wiley publication, 2010.
Clifford A. Shaffer, "Data Structures and Algorithm Analysis", Third Edition, Dover Publications, 2012.
Goodrich M T, Tamassia R and Michael H. Goldwasser, "Data Structures and Algorithms in Python++", Wiley publication, 2013.
Tremblay J P and Sorenson P G, "An Introduction to Data Structures with Applications", Second Edition, Tata McGraw-Hill, 2002.
Klir and Yuan, "Fuzzy sets and Fuzzy Logic; Theory and Applications", Prentice Hall of India Private Limited 2009.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

GENERAL ELECTIVES

19EEE441	NETWORK SYNTHESIS	L-T-P-C: 3-0-0-3

Pre-requisites: Electric Circuits

Course Objectives:

The objective of this course is to analyse different network configurations and to understand the basics of network synthesis.

Course Outcomes:

CO1: Analyze different two port network configurations and parameters
CO2: Identify physically realizable two port networks using various methods.
CO3: Synthesize one-port networks with different combinations of passive elements.
CO4: Reconstruct two-port loaded networks based on transfer functions.
CO5: Realize normalized low pass filter

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2											
CO2	3	3	1											
CO3	3	3	2											
CO4	3	3	2											
CO5	3	3	2		1									

Syllabus

Unit 1
Network functions, two port parameters, incidental dissipation, analysis of ladder networks. Elements of realizability theory, causality and stability, Hurwitz polynomial, Properties of Hurwitz polynomial, The Computation of Residues, Even and Odd functions, Positive real functions, Properties of 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 Y_{21} and Z_{21} with 1Ω 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, simulation of frequency response.

Text Books/ References:

Franklin F Kuo, "Network Analysis and Synthesis", John Wiley & Sons, Third Edition, 1966, reprint 2002.

A Sudhakar, Shyammohan S Palli, "Circuits and Networks – Analysis and Synthesis", Second Edition, Tata Mc Graw Hill Publication, 2006.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE442	OPTO-ELECTRONICS & LASER INSTRUMENTATION	L-T-P-C: 3-0-0-3

Course objective

To introduce concepts of optical transmission and laser technologies and its application in industry and medical field**.**

Course Outcome

CO1: Understanding on fundamental concepts of optical sources, transmission and photo detection
CO2: Familiarity with basic concepts of optical fibers and their properties.
CO3: To introduce to laser characteristics and generation
CO4: Ability to apply laser technologies to industrial and medical applications.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	1	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	1	-	-	-	-	-	-	-	-	-	-
CO4	3	3	3	-	1	-	-	-	-	-	-	-	-	-

Syllabus

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

Text Book(s)
Wilson and Hawkes, "Opto Electronics-An Introduction", Third Edition, Pearson Education, 1998.
John Ready, "Industrial Applications of Lasers", Second Edition, Academic Press, 1997

Reference(s)
Bhattacharya P, "Semiconductor Optoelectronics", Second Edition, Pearson Education, 1998.
Djafar K. Mynbaev, Lowell L. Scheiner, "Fiber-Optic Communications Technology", First Edition, Prentice Hall of India Pvt. Limited, 2000.

R. P. Khare, "Fiber Optics and Optoelectronics", Oxford Press, 2004

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE443	SPECIAL ELECTRIC MACHINES	L-T-P-C: 3-0-0-3

Pre-requisites: Electrical Machines I & II.

Course Objective

To introduce to non-traditional special machines such as stepper motor, switched reluctance motor, permanent magnet synchronous motor and brushless DC motor and expose to industry applications.

Course Outcomes:

CO1: Understanding of principles of operation and control of special electric machines.
CO2: Familiarity with selection of materials and components for special electric machines.
CO3: Ability to model special electric machines.
CO4: Ability to develop controllers for special electric machines.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-											
CO2	3													
CO3	3	3	2	1	1								1	1
CO4	3	2	2	-	1								1	1

Syllabus

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, driver 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 motor
Constructional features, Rotary and Linear SRM's, 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 DC Motors
Principle of operation, types, magnetic circuit analysis, EMF and torque equations, commutation, power controllers, motor characteristics and control, torque/speed characteristics.
Introduction to machine modelling: Kron's primitive machine-abc, alpha-beta, dq frames- modelling of: Induction Motor-PMSM- BLDC- Introduction to flux switching machine.

Text Book:
S.ANasar and I.Boldea, L.E.Unnewehr Permanent Magnet, "Reluctance and Self synchronous motors", CRC Press inc. 1933.

References:
Miller T.J.E."Brushless permanent magnet and reluctances motor drives", Clarendon Press, Oxford, 1989.
T.J.E. Miller (Ed.), "Electronic control of Switched Reluctance Motor", Newman Power Engineering Series, 2001.
Paul Acamley. "Stepping motor- A guide to theory and practice", IEE London,2002.
B.K.Bose, Modern Power Electronics and AC drives", Prentice Hall of India, New Delhi.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE444	ELECTROMAGNETIC COMPATIBILITY	L-T-P-C: 3-0-0-3

Pre-requisites: Electromagnetic Theory

Course Objective

To introduce the concepts of electromagnetic interference and electromagnetic compatibility and to analyze the different EM coupling principles and its impact

Course Outcomes:

CO1: Understanding of requirement of EMI and EMC.
CO2: Ability to investigate the features of electromagnetic interferences.
CO3: Exposure to various methods to prevent electromagnetic interferences
CO4: Knowledge on electromagnetic interferences standards, specifications and test methods.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3	2												
CO3	3													
CO4	3													

Syllabus

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:
Henry W Ott, "Electromagnetic Compatibility Engineering", John Wiley, 2009
Berhard Keiser, "Principles of Electromagnetic Compatibility", Artech House, 3rd Edition, 1995
V.P.Kodali, " Engineering EMC Principles , Measurements and Technologies," IEEE Press,1996

Course Material on Electromagnetic Compatibility, Rajeev Thottappillil, Professor, Electromagnetic Engineering, KTH Royal Institute of Technology, Stockholm.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE445	ILLUMINATION ENGINEERING	L-T-P-C: 3-0-0-3

Course Objectives

To introduce to the fundamentals of illumination engineering and design.

Course Outcomes

CO1: Understanding of characteristics of visible light spectrum and principles of optics.
CO2: Ability to design lighting schemes for various applications.
CO3: Ability to evaluate the performance of various lighting designs.
CO4: Expose to building codes and control schemes of lighting design.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3	2	1											
CO3	3	2												
CO4	3	2				1							1	

Syllabus

Unit 1
Radiant energy and visible spectrum, energy conversion to light, colour, eye and vision; different entities of illuminating systems. Energy efficient illuminating system components: Light sources: daylight, incandescent, electric discharge, fluorescent, arc lamps, lasers, LED and CoB LED; Factors affecting lighting-shadow, glare, reflection, 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. Design of indoor lighting system, Illumination levels, loss factors, lamp selection and maintenance. Special feature for entrance, staircase, Corridor lighting and industrial building

Unit 3
Exterior lighting- Design of outdoor lighting system, flood light, street lighting, 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, Special Features of Aesthetic Lighting: Monument and statue lighting, Sports lighting, Hospital lighting, Auditorium lighting, Smart Green House lighting.

Text Book
Craig DiLouie, "Advanced Lighting Controls: Energy Savings, Productivity, Technology and Applications", CRC Press, 2006

Reference(s)
Kao Chen, "Energy Management in Illuminating Systems", Carlsons Consulting Engineers, San Diego, California, USA, CRC Press, 1999
Mark Stanley Rea, "IESNA Lighting Handbook", Illuminating Engineering Society of North America, 2000
Soni, Gupta and Bhatnagar, "A Course in Electrical Power", Fourth Edition, Dhanpat Rai & Sons, 1996.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE446	COMMUNICATION ENGINEERING	L-T-P-C: 3-0-0-3

Course Objective:

The objective of the course is to learn the fundamentals of analog and digital communication technologies, which supports data communication in modern digital consumer electronics, industrial electronic equipment, electrical tools and gadgets.

Course Outcomes:

CO1: Understand communication systems with reference to Spectrum and Signal to Noise Ratio
CO2: Analyse modulation schemes like AM, FM, PWM, PPM and PCM
CO3: Understand digital communication techniques.
CO4: Select a communication technique based on a given application.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1												1
CO2	3	3	1	1										1
CO3	3													1
CO4	3	3	2	2									3	1

Syllabus

Unit 1
Introduction: Communication, Communication systems - Block diagram 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. Review on digital communication protocols: USART, I2C, SPI, CAN, USB. Lab Practice: Simulation experiments on analog and digital communication methods.

Textbook/References:

George Kennedy, Bernard Davis, "Electronic Communication Systems", Fifth Edition, Tata McGraw Hill Publishing Company Limited, 2006.

Wayne Tomasi, "Electronic Communication Systems, Fundamentals through Advanced", Fourth Edition, Pearson Education 2002.

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.)

Simon Haykin, "An Introduction to Analog and Digital Communication", Fourth Edition, JohnWiley and Sons, 2003.

Taub, Schilling, "Principles of Communication Systems", Tata McGraw Hill Publishing Company Limited, 2004.

Dennis Roddy, John Coolen, "Electronic Communications", Fourth Edition, Pearson Education, 2004.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE447	BIOMEDICAL SYSTEMS	L-T-P-C: 3-0-0-3

Course objective:

To introduce aspects of biomedical engineering from a systems perspective and to use the engineering principles for extracting bio medical information.

Course Outcomes:

CO1: Ability to acquire process and analyze the biomedical signals.
CO2: Knowledge on measurement and interpretation of data from biological sensors
CO3: Ability to apply medical informatics and artificial intelligence methods for biomedical decision making

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3													
CO3	3	2		1	1			1					1	

Syllabus

Unit 1
Biomedical signals: origins and dynamic characteristics, Biomedical signal acquisition and processing. Compression of biomedical signals, Analysis of biomedical signal using advanced techniques (e.g. neural networks, orthogonal transformations including singular value decomposition) and wavelet transformation, higher order spectra).

Unit 2
Nonlinear dynamical analysis of biomedical signals, Physiological modelling, identification and simulation. Control of physiological processes and computer controlled drug infusion medical signaling (including CT Scan, MRI and Ultrasound). Medical Informatics, Artificial intelligence methods for medical decision making

Unit 3
Study of biological sensors: Sensors / receptors in the human body, basic organization of nervous system-neural mechanism and circuit processing. Chemoreceptor: hot and cold receptors, barro receptors, sensors for smell, sound, vision, osmolality and taste. Sensor models in the time and frequency domains.

Textbooks/References:
R. S. Khandpur "Handbook of Bio-Medical Instrumentation", Tata McGraw Hill, 2014
Carr & Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia,2002
Cromwell, Weibell & Pfeiffer, "Biomedical Instrumentation & Measurement", Prentice Hall, India,2001

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE448	BIOLOGICAL CONTROL SYSTEMS	L-T-P-C: 3-0-0-3

Pre-requisites: Control Systems

Course Objectives:

To impart knowledge on modeling and control of biological systems.

Course Outcomes:
CO1: Understanding of dynamics of cardiac, respiratory, neuromuscular systems.
CO2: Ability to model and characterize the cardiac, respiratory, Neuromuscular systems in time and frequency domains.
CO3: Ability to analyze the stability of biological systems.
CO4: Ability to apply the adaptive control scheme for biological systems.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				-		-	-	-	-	-	-		-
CO2	3	2		1	-		-	-	-	-	-	-	-	-
CO3	3	2	2	1	-		-	-	-	-	-	-	-	-
C04	3	2	2	2	2								1	1

Syllabus

Unit1:
Biological Control Systems Analysis. Comparison of Engineering and Biological Control System. Mathematical modelling of Biological (Physiological) Systems: Transfer function and State-Space Analysis, Computer Analysis and Simulation.
Unit2:
Static Analysis of Biological Systems: Regulation of Cardiac Output, Regulation of Glucose, Chemical Regulation of Ventilation. Time-Domain Analysis: Linearized Respiratory Mechanics, Dynamics of Neuromuscular Reflex Motion. Frequency-Domain Analysis of Biological systems: Frequency Response of a Model of Circulatory Control, Frequency Response of Glucose-Insulin Regulation.

Unit3:
Stability Analysis: Stability Analysis of the Pupillary Light Reflex Model of Cheyne-Stokes Breathing. Identification of Biological Control Systems: Identification of Closed-Loop Systems, Case studies. Optimization in Biological Control: Adaptive Control of Biological Variables. Nonlinear Analysis of Biological Control Systems: Models of Neuronal Dynamics

Text Books/ References:

Michael C.K. Khoo, "Physiological Control Systems: Analysis, Simulation and Estimation". John Wiley & Sons, Inc., 2012.
Schlick, T., " Molecular Modeling and Simulation: An Interdisciplinary Guide". New York, NY: Springer, 2002.
Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
Barry R. Dworkin, "Learning and Physiological Regulation (Hardcover)", University Of Chicago Press, March 1993.

E. Carson, E. Salzsieder, "Modelling and Control in Biomedical Systems ", 2000 (including Biological Systems) (IFAC Proceedings Volumes) (Paperback), Pergamon Publishing.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19EEE449	3D PRINTING AND DESIGN	L-T-P-C: 3-0-0-3

Course Objective:

The course is designed to impart knowledge and skills related to 3D printing technologies selection of material and equipment and develop a product using this technique.

Course Outcomes:

CO1: Develop CAD models for 3D printing
CO2: Import and Export CAD data and generate .stl file
CO3: Select a specific material for the given application
CO4: Select a 3D printing process for an application
CO5: Develop a product using 3D printing or Additive Manufacturing (AM)

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3		3									
CO2	3		3		3									
CO3	3	2	2		3									
CO4	3	1	1	2	3								1	2
CO5	3			3	3								2	1

Syllabus

Unit 1
3D Printing (Additive Manufacturing): Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing, processes, Applications. CAD for Additive Manufacturing.
CAD Data formats, Data translation, Data loss, STL. format.
Additive Manufacturing Techniques: Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology.

Unit 2
Process, Process parameter. Process Selection for various applications.
Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive. Construction, Food Processing, Machine Tools
Materials: Polymers, Metals, Non-Metals, Ceramics. Various forms of raw material- Liquid, Solid, Wire, Powder, Powder Preparation and their desired properties, Polymers and their properties. Support Materials.

Unit 3
Additive Manufacturing Equipment
Process Equipment- Design and process parameters, Governing Bonding Mechanism, Common faults and troubleshooting, Process Design. Post Processing: Requirement and Techniques.
Product Quality: Inspection and testing, Defects and their causes

Text Books/References:

Lan Gibson, David W. Rosen and Brent Stucker. "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing". Springer. 2010.

Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping. Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.

Khanna Editorial, "3D Printing and Design". Khanna Publishing House. Delhi.

CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2017.

J.D, Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials". Springer Series in Material Science, 2013.

L. Lu, J. Fuh and Y.S. Wong. "Laser-Induced Materials and Processes for Rapid Prototyping", Kulwer Academic Press, 2001.

Zhiqiang Fan and Frank Liou, "Numerical Modelling of the Additive Manufacturing (AM) Processes of Titanium Alloy". InTech, 2012.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19ECE331	BIOMEDICAL INSTRUMENTATION	L-T-P-C: 3-0-0-3

Pre-requisites: Electrical Measurements

Course Objective

To introduce to the concept of bio signals, its acquisition, conditioning and imaging techniques used in bio medical instrumentation.

Course Outcomes:

CO1: Understanding on basics of bio-medical signals and sensors
CO2: Ability to apply the concepts of sensors and transducers for acquiring bio-signals and related signal conditioning circuits.
CO3: Familiarity with therapeutic and diagnostic methods using bio-medical instrumentation systems.
CO4: Learning on modern methods of imaging techniques used for bio-medical applications and related standards.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-												
CO2	3	2	1											
CO3	3													
CO4	3				2			2					1	1

Syllabus

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 - Robotic Surgery – Advanced 3D sugical techniques - Electrical Safety codes and standards – Protection of patients. Case study – wireless health monitoring.

Text Book / References:

R S Khandpur, "Handbook of Biomedical Instrumentation", 1st ed., Tata McGraw Hill Publishing Company Limited, 2014

John G Webster, "Medical Instrumentation - Application and Design", 4th ed., John Wiley and Sons, 2007.

Leslie Cromwell, Fred. J. Weibell, Erich. A. Pfeiffer, "Biomedical Instrumentation & Measurements, 2nd ed., Pearson Education., 2001.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

19MNG331	FINANCIAL MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objectives:

To introduce to the financial planning and budgeting techniques.

Course Outcomes:

CO1: Understanding of the rationale of finance planning and budgeting.
CO2: Ability to estimate financial requirement, cost of capital and values of bonds and shares.
CO3: Exposure to capital budgeting & risk analysis.
CO4: Knowledge on techniques of working capital management, cash management, inventory management, receivable management and dividend decision.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3	2												
CO3	3	2												
CO4	3	2												

Syllabus

Unit 1
Financial Management: Introduction, Definitions, Goals, Functions, Interface between Finance and Other Business Functions. Financial Planning: Objectives, Benefits, Steps in Financial Planning, Factors affecting financial Planning, Estimation of Financial Requirements of a Firm, Capitalization, Time Value of Money, Valuation of Bonds and Shares. Cost of Capital: Cost of Different Sources of Finance, Weighted Average Cost of Capital.

Unit 2
Leverage: Operating Leverage, Financial Leverage, Combined Leverage, Applications. Capital Structure: Ideal Capital Structure, Factors Affecting Capital Structure, Theories of Capital Structure. Capital Budgeting: Capital Budgeting Decisions, Phases of Capital Expenditure Decisions, Identification of Investment Opportunities, Rationale of Capital Budgeting Proposals, Capital Budgeting Process, Investment Evaluation, Risk Analysis in Capital Budgeting, Capital Rationing, Various Approaches to Capital Rationing.

Unit 3
Working Capital Management: Components of Current Assets and Current Liabilities, Concepts of Working Capital, Operating Cycle, Determinants, Estimation and management of Working Capital. Cash Management: Objectives, Models for Determining Optimal Cash Needs, Cash Planning, Cash Forecasting and Budgeting. Inventory Management: Introduction, Role of Inventory in Working Capital, Characteristics of inventory, Inventory Management Techniques. Receivable Management: Costs Associated with Maintaining Receivables, Credit Policy Variables, Evaluation of Credit Policy. Dividend Decisions: Traditional Approach, Stability of Dividends, Forms of Dividends, Stock Split.

Textbook/References:

Khan M.Yand.Jain P.K, Financial Management, Text, Problems and Cases - Tata McGraw

Pandey I.M, Financial Management, Vikas Publishing House Pvt. Ltd.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.