M Sc – Mathematics (2 Years)

CURRICULUM AND SYLLABUS

(From 2018 Admission Onwards)

Vision of the Institute

To be a global leader in the delivery of engineering education, transforming individuals to become creative, innovative, and socially responsible contributors in their professions.

Mission of the Institute:

1. To provide best-in-class infrastructure and resources to achieve excellence in technical education,
2. To promote knowledge development in thematic research areas that have a positive impact on society, both nationally and globally,
3. To design and maintain the highest quality education through active engagement with all stakeholders –students, faculty, industry, alumni and reputed academic institutions,
4. To contribute to the quality enhancement of the local and global education ecosystem,
5. To promote a culture of collaboration that allows creativity, innovation, and entrepreneurship to flourish, and
6. To practice and promote high standards of professional ethics, transparency, and accountability

PROGRAM OUTCOMES (PO)

PO1 **Knowledge in Mathematical Science:** Understand the basic concepts, fundamental principles and the scientific theories related to mathematical sciences.

PO2 **Abstract thinking:** Ability to absorb and understand the abstract concepts that lead to various advanced theories in mathematical sciences.

PO3 **Modeling and solving:** Ability in modeling and solving problems by identifying and employing the appropriate existing theories and methods.

PO4 **Advanced theories and methods:** Understand advanced theories and methods to design solutions for complex mathematical problems.

PO5 **Applications in Engineering and Sciences:** Understand the role of mathematical sciences and apply the same to solve the real life problems in various fields of study.

PO6 **Modern software tool usage:** Acquire the skills in handling scientific tools towards problem solving and solution analysis.

PO7 **Environment and sustainability:** Understand the significance of preserving the environment towards sustainable development.

PO8 **Ethics:** Imbibe ethical, moral and social values in personal and social life leading to highly cultured and civilized personality. Continue to enhance the knowl edge and skills in mathematical sciences for constructive activities and demonstrate highest standards of professional ethics.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication:** Develop various communication skills such as reading, listening, and speaking which will help in expressing ideas and views clearly and effectively.

PO11 **Project management and Research:** Demonstrate knowledge, understand the scientific and management principles and apply these to one’s own work, as a member/ leader in a team to manage projects and multidisciplinary research environments. Also use the research-based knowledge to analyse and solve advanced problems in mathematical sciences.

PO12 **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.

M Sc – Mathematics (2 Years)

CURRICULUM

(From 2018 Admission Onwards)

SEMESTER 1				
Course Code	**Course Title**	**L T P**	**Cr**	**ES**
18MAT502	Advanced Algebra	4 0 0	4	A
18MAT503	Advanced Real Analysis	4 0 0	4	B
18MAT504	Ordinary Differential Equations	4 0 0	4	C
18MAT505	Stochastic Process	4 0 0	4	C
18MAT581	Mathematics Lab	0 0 2	1	L1
	Elective I	3 0 0	3	E
	TOTAL		**20**	

SEMESTER 2				
Course Code	**Course Title**	**L T P**	**Cr**	**ES**
18MAT511	Advanced Complex Analysis	4 0 0	4	A
18MAT512	Advanced Topology	4 0 0	4	A
18MAT513	Partial Differential Equations	4 0 0	4	B
18MAT514	Measure Theory	4 0 0	4	C
18MAT515	Numerical Analysis	3 0 0	3	E
18MAT582	Numerical Computations Lab	0 0 2	1	L1
	TOTAL		**20**	

SEMESTER 3				
Course Code	**Course Title**	**L T P**	**Cr**	**ES**
18MAT601	Advanced Graph Theory	4 0 0	4	A
18MAT602	Functional Analysis	4 0 0	4	B
18MAT603	Basic Fluid Dynamics	4 0 0	4	C
	Elective II	3 0 0	3	D
	Elective III	3 0 0	3	E
18MAT691	Seminar	0 0 2	1	F
	TOTAL		**19**	

SEMESTER 4				
Course Code	**Course Title**	**L T P**	**Cr**	**ES**
18MAT611	Operator Theory	4 0 0	4	A
	Elective IV	3 0 0	3	E
18MAT696	Dissertation		10	P
	TOTAL		**17**	
	TOTAL	**216**		

ELECTIVES (any one Stream)				
ALGEBRA STREAM				
18MAT631	Algebraic Geometry	3 0 0	3	D/E
18MAT633	Algebraic Topology	3 0 0	3	D/E
18MAT634	Coding Theory	3 0 0	3	D/E
18MAT635	Commutative Algebra	3 0 0	3	D/E
18MAT636	Lie Algebra	3 0 0	3	D/E
18MAT637	Theory of Manifolds	3 0 0	3	D/E
18MAT638	Linear Algebra and its Applications	3 0 0	3	D/E
STATISTICS STREAM				
18MAT651	Queuing Theory and Inventory Control Theory	3 0 0	3	D/E
18MAT653	Statistical Pattern Classifications	3 0 0	3	D/E
18MAT654	Statistical Quality Control and Six Sigma Quality Analysis	3 0 0	3	D/E
18MAT655	Theory of Sampling and Design of Experiments	3 0 0	3	D/E
18MAT656	Time Series Analysis	3 0 0	3	D/E
18MAT657	Statistical Techniques For Data Analytics	3 0 0	3	D/E
COMPUTER STREAM				
18MAT671	Data Structures & Algorithms	3 0 0	3	D/E
18MAT672	Algorithms For Advanced Computing	3 0 0	3	D/E
18MAT673	Computer Aided Design of VLSI Circuits	3 0 0	3	D/E
18MAT674	Cryptography	3 0 0	3	D/E
18MAT675	Fuzzy Sets and its Applications	3 0 0	3	D/E
18MAT676	Introduction to Soft Computing	3 0 0	3	D/E
18MAT677	Object-Oriented Programming and Python	3 0 0	3	D/E
ANALYSIS STREAM				
18MAT641	Fixed Point Theory	3 0 0	3	D/E
18MAT642	Fractals	3 0 0	3	D/E
18MAT643	Harmonic Analysis	3 0 0	3	D/E
18MAT644	Nonlinear Partial Differential Equations	3 0 0	3	D/E
18MAT645	Wavelet Analysis	3 0 0	3	D/E
18MAT646	Mathematical Physics	3 0 0	3	D/E
FLUID MECHANICS STREAM				
18MAT661	Advance Boundary Layer Theory	3 0 0	3	D/E
18MAT662	Computational Fluid Dynamics	3 0 0	3	D/E
18MAT663	Finite Element Methods	3 0 0	3	D/E
18MAT664	Magneto-Hydro Dynamics	3 0 0	3	D/E
18MAT665	Mathematical Foundations of Incompressible Fluid Flow	3 0 0	3	D/E

LANGUAGES - Paper I				
18HIN101	Hindi I	1 0 2	2	B
18KAN101	Kannada I	1 0 2	2	B
18MAL101	Malayalam I	1 0 2	2	B
18SAN101	Sanskrit I	1 0 2	2	B
LANGUAGES - Paper II				
18HIN111	Hindi II	1 0 2	2	B
18KAN111	Kannada II	1 0 2	2	B
18MAL111	Malayalam II	1 0 2	2	B
18SAN111	Sanskrit II	1 0 2	2	B

* **Two Open Elective** courses are to be taken by each student, one each at the **4th and the 5th** semesters, from the list of Open electives offered by the School.

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

Evaluation Pattern

50:50 (Internal: External) (All Theory Courses)

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

80:20 (Internal: External) (Lab courses and Lab based Courses having 1 Theory hour)

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

70:30(Internal: External) (Lab based courses having 2 Theory hours/ Theory and Tutorial)

Theory- 60 Marks; Lab- 40 Marks

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	10	
Continuous Assessment (Lab) (CAL)	40	
End Semester		30

65:35 (Internal: External) (Lab based courses having 3 Theory hours/ Theory and Tutorial)

Theory- 70 Marks; Lab- 30 Marks

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.

Letter Grade	**Grade Point**	**Grade Description**
O	10.00	Outstanding
A+	9.50	Excellent
A	9.00	Very Good
B+	8.00	Good
B	7.00	Above Average
C	6.00	Average
P	5.00	Pass
F	0.00	Fail

Grades O to P indicate successful completion of the course

$$CGPA = \frac{\sum (C_i x Gr_i)}{\sum C_i}$$

Where

C_i = Credit for the i^{th} course in any semester

Gr_i= Grade point for the i^{th} course

Cr. = Credits for the Course

Gr. = Grade Obtained

Program Articulation Matrix

Subject	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
18MAT502	3	1	1	3	1	1					3	0
18MAT503	3	1	1	3	1	1					3	0
18MAT504	3	2	2	3	2	1					3	0
18MAT505	2	2	1	2	3						2	
18MAT581	2	3	3	1	2	3					2	1
18MAT511	3	1	1	3	1	1					3	0
18MAT512	3	1	1	3	1	1					3	0
18MAT513	3	2	2	3	2	1					3	0
18MAT514	3	1	1	3	1	1					3	0
18MAT515	3	3	2	1	2	3					1	1
18MAT582	2	3	3	1	2	3					2	1
18MAT601	3	2	2	1	2	1					1	0
18MAT602	3	1	1	3	1	1					3	0
18MAT603	2	2	3	2	3	1					2	0
18MAT691	3	2	1	1	1						1	
18MAT611	3	1	1	3	1	1					3	0
18MAT696	3	1	2	3	1	1		1	2	3	3	1
18MAT631	3	1	1	3	1						3	0
18MAT633	3	1	1	3	1						3	0
18MAT634	2	2	2	2	3						2	0
18MAT635	3	1	1	3	1						3	0
18MAT636	3	1	1	3	1						3	0
18MAT637	3	1	1	3	1						3	0
18MAT638	3	2	1	2	3	1					2	
18MAT641	3	1	1	3	1						3	0
18MAT642	3	2	3	2	3	1					2	
18MAT643	3	1	1	3	1						3	0
18MAT644	3	2	2	3	2	1					3	0
18MAT645	3	2	3	2	3	1					2	
18MAT646	3	2	3	2	3	1					2	
18MAT651	2	3	2	1	2	2					1	
18MAT653	2	3	2	2	3	2					2	
18MAT654	2	3	2	2	3	2					2	
18MAT655	2	3	3	1	2	2					2	1
18MAT656	2	2	3	3	2	2					1	
18MAT657	2	2	3	3	2	2					1	1
18MAT658	1	1	2	1	2	3					1	1
18MAT661	2	2	3	3	3	2					2	
18MAT662	2	2	3	3	3	2					2	
18MAT663	2	3	2	2	3	3					2	
18MAT664	2	2	3	3	3	2					2	
18MAT665	2	2	3	3	3	2					2	

18MAT666	2	2	3	2	3	1					2	0
18MAT671	2	1	1	1	3	2					1	1
18MAT672	2	1	1	1	3	2					1	1
18MAT673	1	1	2	1	3	2					1	
18MAT674	2	1	1	1	3	2					1	
18MAT675	3	2	2	1	2	1					1	
18MAT676	1	2	1	2	2	3					1	
18MAT677	2	1	1	1	3	2					1	1

M Sc – Mathematics (2Years)

SYLLABI

(From 2018 Admission Onwards)

18MAT502 **Advanced Algebra** **3 1 0 4**

Unit 1

Conjugate Elements, Normalizer of an Element, Index of Normalizer, Center of a Group, Cauchy's Theorem on Prime Order, the Number of Conjugate Classes $p(n)$ for a Permutation Group, Counting Principles, Cauchy Theorem, p- Sylow subgroups, Sylow's Theorems. **(Sec. 2.11 and 2.12).**

Unit 2

Normal Subgroups, Isomorphic Groups, External and Internal Direct Products, Cyclic Groups, Abelian Groups, Invariants of a Group, Fundamental Theorem on Finite Abelian Groups **(Sec. 2.13 and 2.14).**

Unit 3

Polynomial Rings over the Rational Field, Primitive Polynomials, The Content of a Polynomial, Integer Monic Polynomial, Eisenstein Criterion, Polynomial Rings over Commutative Rings. Unique Factorisation domain **(Sec. 3.10 to 3.11).**

Unit 4

Euclidean Domains, Principal Ideal Domains, Unique Factorization Domains, Polynomials in Several Variables over a Field and Grobner Bases. **(Sec. 8.1 to 8.3, 9.6 from Reference Book 1).**

Unit 5

The Elements of Galois Theory, Group of Automorphisms and its fixed field, Galois Group, The Fundamental Theorem of Galois Theory, Solvable Groups, Solvability by Radicals, Galois Groups over the Rationals.
(Sec. 5.6 to 5.8).

Course Outcome

CO-1: To derive the class equation and use it in various counting problems. To derive Cauchy's/ Sylow's theorem for general groups.
CO-2: To understand direct product and to apply Sylow's theorem to Classify finite Abelian Groups.
CO-3: To understand polynomial rings over rational fields and identify irreducible polynomials through standard theorems.
CO-4: To study in details special cases of integral domains. To familiarize the concept of Grobner Bases and its applications.
CO-5: To familiarize Galois theory and its use in analyzing the solvability by radicals of polynomial equations.

TEXT BOOK:

1. *I. N. Herstein, 'Topics in Algebra', Second Edition, John Wiley and Sons, 2000.*

REFERENCES BOOKS:

1. *D.S. Dummit and R. M. Foote, 'Abstract Algebra', 2nd Ed., John Wiley, 2002.*
2. *M.Artin, 'Algebra', Prentice Hall inc 1994.*
3. *Joseph Rotman,'Galois Theory', 2^{nd} Ed., Springer, 2001.*

Note: *The Problems are to be referred from Reference Book 1.*

18MAT503 **Advanced Real Analysis** **3-1-0-4**

Unit 1

Riemann-Stieltjes Integral: Definition and Existence of the Integral, Properties of the Integral, Integration and Differentiation, Integration of vector-valued functions, Rectifiable curves.
(Chapter 6: 6.1 to 6.5)

Unit 2

Sequences and Series of Functions: Sequence of functions and its point-wise limit, Discussion of main problems, Uniform convergence, Uniform convergence and continuity, Uniform convergence and Integration, Uniform convergence and Differentiation, Equicontinuous Families of Functions, The Stone-Weierstrass Theorem.
(Chapter 7: 7.1 to 7.7)

Unit 3

Some Special Functions: Introduction to power series, The Exponential and Logarithmic Functions, The Trigonometric Functions, The Algebraic Completeness of the Complex Field.
(Chapter 8: 8.1 to 8.4)

Unit 4

Some Special Functions and Functions of Several Variables: Fourier series, Gamma function and its properties. Linear Transformation, Differentiation.
(Chapter 8 & 9: 8.5 to 8.6. 9.1 to 9.2)

Unit 5

Functions of Several Variables: The Contraction principle, The inverse function theorem, The implicit function theorem
(Chapter 9: 9.3 to 9.5)

Course outcomes

CO1- Understanding Riemann-Stieltjes Integral and applying it to evaluate length of the Rectifiable curves
CO2- Understanding Equicontinuous Families of Functions and The Stone-Weierstrass Theorem.
CO3- Understanding special functions and algebraic completeness of the complex field
CO4- Applying the concept of derivatives in functions of several variables.
CO5- Understanding Contraction principle, The inverse function theorem, The implicit function theorem.

TEXT BOOK:

1. *Rudin. W, "Principles of Mathematical Analysis", McGraw-Hill International Editions, Third Edition, 1976.*

REFERENCE BOOKS:

1. *H.L. Royden and P.M.Fitzpatrick, "Real Analysis", Pearson Education Asia Limited, Fourth Edition, 2010.*
2. *Tom M. Apostol, "Mathematical Analysis", Narosa publishing house, New Delhi, Second Edition, 1989.*

18MAT504 ORDINARY DIFFERENTIAL EQUATIONS 3 1 0 4

(Prerequisite: The students must know the basic concepts on ordinary differential equation.)

Unit 1

Linear differential equations: Introduction, initial value problems, the wronskian and linear independence, reduction of order of a homogeneous equation, non-homogeneous equation. **TB2 (3.1-3.6)(4 hours)**

Existence - Uniqueness of Solutions to First Order Equations: Equations with variable separated, Exact equations, the method of successive approximations, Lipschitz condition, Convergence of successive approximations, Non–local existence of solutions, Approximations to, and uniqueness, of solutions. **TB2 (5.2- 5.8)(10hours)**

Unit 2

Systems of first order equations, Existence and uniqueness theorem, fundamental matrix, nonhomogenous linear systems, linear systems with constant coefficients. **TB3 (4.2-4.7) (10 hours)**
An example – central forces and planetary motion, Some special equations.
TB2 (6.2- 6.3)(4 hours)

Unit 3

Complex n-dimensional space, Systems as vector equations, Existence and uniqueness of solutions to systems, Existence and Uniqueness of linear systems, Equations of order n.
TB2 (6.4- 6.8) (10 hours)

Unit 4

Nonlinear equations: Autonomous Systems, The Phase plane and its phenomena, Types of critical points. Stability, critical points and stability for linear systems, Stability by Liapunov's Direct method, stability by eigen values, Simple critical points of nonlinear systems.**TB1 (11.58- 11.62) (10 hours)**

Unit 5

Nonlinear mechanics, Conservative systems, Periodic solutions, The Poincaré–Bendixson theorem.
Oscillations and the Sturm Separation theorem, The Sturm comparison theorem.
TB1 (11.63- 11.64), (4.24-4.25) (7 hours)

<u>Course Outcomes</u>

CO-1: Understand the existence - uniqueness conditions of solutions to first order equations and apply various methods to solve the initial value problems.
CO-2: Understand the concepts of the existence and uniqueness theorem, fundamental matrix, homogenous/nonhomogenous linear systems with constant coefficients and solve the problems involving central forces, planetary motion and some special equations.
CO-3: Understand the concepts of a complex n-dimensional space, the systems as vector equations, existence and uniqueness of solutions to systems.
CO-4: Understand the concepts of nonlinear equations, autonomous systems, the phase plane and its phenomena and stability for linear and nonlinear systems.
CO-5: Understand the concepts of periodic and oscillatory behaviours of a differential equation.

TEXT BOOKS:

1. *George F. Simmons and John S Robertson, Differential equations with applications and historical notes, Tata McGraw Hill Education Private Limited, Second Edition, 2003.*
2. *E.A. Coddington, An introduction to ordinary differential equations, PHI learning, 1999.*

3. *S. G. Deo, V. Lakshmikantham and V Raghavendra, Text book of Ordinary differential equations, McGraw Hill Education Private Limited, second edition, 2013.*

REFERENCE BOOK:

1. *William E. Boyce and Richard C. DiPrima, Elementary differential equations and boundary value problems Wiley India, 9th edition, 2012.*

18MAT505 **Stochastic Processes** **3 1 0 4**

Unit – I

Introduction to Probability and Stochastic Processes:
Definition of Stochastic Processes, specification of Stochastic processes, Stationary processes– Markov Chains: definition and examples, higher transition probabilities, Generalization of Independent Bernoulli trails, classification of states and chains.
(Sections: 2.1, 2.2, 2.3, 3.1, 3.2, 3.3, 3.4)

Unit – II

Markov Processes with Discrete State Space:
Poisson process, Poisson process related distributions, properties of Poisson process, Generalizations of Poisson Processes, Birth and death processes, continuous time Markov Chains.
(Sections: 4.1, 4.2, 4.3, 4.4, 4.5)

Unit – III

Markov processes with continuous state space:
Brownian motion – Wiener Process - Differential equations for a Wiener process – Kolmogorov equations – first passage time distribution for Wiener process – Ornstein-Uhlenbech process.
(Sections: 5.1 to 5.6)

Unit – IV

Renewal processes and theory:
Renewal process – Renewal processes in continuous time – Renewal equation – stopping time – Wald's equation – Renewal theorems.
(Sections: 6.1 to 6.5)

Unit – V

Branching Processes:

Introduction, properties of generating functions of Branching process, Distribution of the total number of progeny, Continuous-Time Markov Branching Process, Age dependent branching process: Bellman-Harris process.
(Sections: 9.1, 9.2, 9.4, 9.7, 9.8)

<u>Course Outcomes</u>

- CO1. Understand the concepts of stochastic process, markov chains and classifical of states and chains.
- CO2. Understand the markov process with discrete state space as poisson process and its properties with related theorems.

CO3. Understand the markov process with continuous state space as wiener process and its properties.
CO4. Understand the renewal process and related theorems.
CO5. Understand the concepts of branching process and Bellman-Harris process.

TEXT BOOK:

1. *J. Medhi, "Stochastic Processes", 2nd Edition, New Age International Private limited, 2006.*

REFERENCE BOOKS:

1. *Sheldon M. Ross, "Stochastic Processes", 2nd Edition, Wiley, 1995.*
2. *J. Ravichandran, "Probability and Random Processes for Engineers", 1st Edition, IK International, 2015.*

18MAT581 Mathematics Lab 0 0 2 1

Introduction to a Mathematical software

Explorations of various applications

Implementation of Mathematical techniques.

18MAT511 ADVANCED COMPLEX ANALYSIS 3 1 0 4

Unit 1: Schwarz Reflection:

Schwarz Reflection by complex conjugation, Reflection along analytic Arcs, Application of Schwarz Reflection (Chapter 9)

Unit 2 : The Riemann Mapping Theorem:

Compact sets in Function Spaces, Statement and Proof of the the Riemann Mapping Theorem, Behaviour at the Boundary (Chapter 10).

Unit 3 : Analytic Continuation:

Analytic Continuation along a curve, Monodromy Theorem, the Dilogrithm, Bloch-Wigner Function, Picard's Theorem and its Application (Chapter 11)

Unit 4 : Entire and Meromorphic Functions: Infinite Products, Absolute Convergence, Weierstrass Products, Functions of Finite Order, Canonical product, Minimum Modulus Theorem, Hadamard's Theorem, Mittag-Leffler Theorem (Chapter 13) .

Unit 5 : Elliptic Functions: Liouville Theorem, Fundamental Parallelogram, Elliptic Function, Weierstrass Function, Addition Theorem, Sigma and Zeta Functions (Chapter 14)

<u>Course Outcomes</u>

CO1: Understand the concept of the Schwarz Reflection by complex conjugation, and its Applications.

CO2:Understand the Riemann Mapping theorem.

CO3:Understand the Analytic Continuation.

CO4:To understand about the entire function and meromorphic function.

CO5:Understand about the Elliptic functions.

TEXT BOOK:

Serge Lang, 'Complex Analysis' Springer, 4th Edition, First Indian Reprint 2005.

REFERENCES BOOKS:

1. S. Ponnusamy and H. Silverman, Complex Variables with Applications, Springer, 2006.
2. R. Roopkumar, Complex Analysis, Pearson Education, 2014, Chennai
3. Lars V. Ahlfors, Complex Analysis, 2ndEdition, McGrawHill, New York, 1966.

18MAT512 Advanced Topology 3 1 0 4

Unit 1 *Continuous Functions :* Continuous functions , homeomorphisms, Rules for Constructing continuos Functions, Pasting Lemma, the product topology, Projection, Box and Product topologies, the metric topology, Metrizable Space, Uniform metric and Uniform Topology, Sequence Lemma, Uniform Convergence, Uniform Limit Theorem.
Chapter 2: Sections 18 to 21

Unit 2 Connectedness: Connected spaces, separation, connected subspaces of the Real line, Linear Continuum, Intermediate Value Theorem, Path and Pathe connectedness , Components, Path Components, locally connected, Locally Path Connected.
Chapter 3: Sections 23 to 25.

Unit 3 Compactness: Compact spaces , Covering and Open Covering, Tube Lemma, Finite Intersection Property, Compact subspaces of the Real line, Extreme Value Theorem, Lebesgue Number Lemma, Uniform Continuity Theorem, Limit Point Compactness , Sequentially Compact, Local Compactness Compactification, One Point Compactification,.
Chapter 3: Sections 26 to 29

Unit 4 Countability and Separation Axioms The First and Second Countability Axioms , The separation Axioms, Regular and Normal spaces, The Urysohn Lemma, Completely Regular Spaces, The Urysohn metrization
Theorem , Imbedding Theorem, The Tietze extension theorem.
Chapter 4: Sections 30 to 35

Unit 5 The Tychonoff Theorem and Baire Space Tychonoff's Theorem , Baire Spaces, Baire Category Theorem. Chapter 5: Section 37 and Chapter 8: Section 48

<u>Course Outcomes</u>

- CO-1: To understand the basic definition of continuity in topological space and its properties through examples. To study the rules for constructing continuous functions and topological spaces.To understand the relationship between two topological spaces.
- CO-2: To understand the concepts of connected spaces, separation, path connectedness and locally connected through examples.

CO-3: To study the basic properties of compact spaces. To understand the concepts of limit point compactness, sequentially compact, local compactness, compactification, one point compactification through examples.

CO-4: To understand countability axioms , separation axioms and its properties.

CO-5: To understand the behaviour of compactness in product topology and properties of completeness through Tychonoff's theorem and Baire category theorem respectively.

TEXT BOOK:

J.R. Munkers- "Topology" -Prentice Hall of India -2002- Second Edition.

REFERENCE BOOKS :

1. J. Dugundji -" Topology" Allyn and Bacon, Boston-1966.
2. K. D. Joshi -"Introduction to General Topology" Wiley Eastern Limited -2012- Revised Edition
3. M. A. Armstrong "Basic Topology" Springer (India) – 2005
4. S. Kumaresan-"Topology of Metric Spaces"- Narosa Publishing House, New Delhi, 2011-Second Reprint.
5.G.F.Simmons-"Introdution to Topology and Modern Analysis" McGraw Hill Education-2004

18MAT513 PARTIAL DIFFERENTIAL EQUATIONS 4 0 0 4

Prerequisite: *The students must know the basic concepts on Calculus (both differential and integral), Differential Equations (ODE and PDE at UG Level), either metric space or topology to understand the words open set, closed set, compact, connected, region, continuous function, Vector Calculus in which the notion of curves, surfaces, tangent plane, normal, surface integral and volume integral and their evaluation, Fourier series and Fourier transforms.*

Unit 1

Geometrical interpretation of a first-order pde, method of characteristics and general solutions, Monge cone, Lagrange's equations, canonical forms of first-order linear equations, method of separation of variables. **Tb1:(2.4-2.8)**

Unit 2

Second-order equations in two independent variables, canonical forms, equations with constant coefficients, general solutions. **Tb1: (4.1-4.6)**

Unit 3

The Cauchy problem, the Cauchy-Kowalewskaya theorem, homogeneous wave equations, the D'Alembert solution of wave equation, initial boundary-value problems, equations with nonhomogeneous boundary conditions, vibration of finite string with fixed ends,.(review) nonhomogeneous wave equations. **Tb1:(5.1-5.7)**

Unit 4

Basic concepts, types of boundary-value problems, maximum and minimum principles, uniqueness and continuity theorems. Dirichlet problem for a circle, Dirichlet problem for a circular annulus, Neumann problem for a circle, Dirichlet problem for a rectangle, Dirichlet problem involving the Poisson equation, the Neumann problem for a rectangle
Tb1:(9.1-9.10)

Unit 5

Derivation of the heat equation and solutions of the standard initial and boundary value problems, uniqueness and the maximum principle, time-independent boundary conditions, time-dependent boundary conditions.**TB2: (3.1-3.4) (10 hours)**

Course Outcomes

CO-1: Understand the geometrical interpretation, characteristics and general solutions of a first-order pde, and solve it by various methods.

CO-2: Understand the concepts of a second-order pde, its canonical forms and the procedure for obtaining the general solutions.

CO-3: Understand the concepts of the Cauchy problem, initial & boundary-value problems and homogeneous/ nonhomogeneous wave equations..

CO-4: Understand the various types of boundary-value problems, maximum/minimum principles and uniqueness and continuity theorems.

CO-5: Understand the concepts of the heat equation, its solutions and the initial and boundary value problems with time- dependent and time-independent boundary conditions.

TEXT BOOKS:

1. *Tyn Myint-U, Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, Birkhauser, Boston, Fourth Edition, 2007.*
2. *D. Bleecker, G. Csordas, Basic Partial Differential Equations, Van Nostrand Reinhold, New York, 1992.*

REFERENCES BOOKS:

1. *L.C. Evans, Partial Differrential Equations, Graduate Studies in Mathematics, Vol. 19, AMS, Providence, 1998.*
2. I.N. Sneddon, Elements of partial differential equations, McGraw Hill, New York, 1986.
3. E. Zauderer, Partial Differrential Equations of Applied Mathematics, John Wileys & Sons, New York, 2nd edition, 1989.
4. E. C. Zachmanoglou and D. W. Thoe, Introduction to Partial Differential Equations with Applications, Dover Publication, New York, 1986.

18MAT514 MEASURE THEORY 3 1 0 4

Unit 1 (Sections: 2.1 to 2.5 of [1])
Measure on the Real Line: Lebesgue Outer Measure - Measurable Sets – Regularity - Measurable Functions - Borel and Lebesgue Measurability

Unit 2 (Sections: 3.1 to 3.4 of [1])
Integration of Functions of a Real Variable: Integration of Non-Negative Functions - The General Integral - Integration of Series - Riemann and Lebesgue Integrals.

Unit 3 (Sections: 5.1 to 5.6 of [1])
Abstract Measure Spaces: Measures and Outer Measures - Extension of a Measure -Uniqueness of the Extension - Completion of a Measure - Measure Spaces - Integration with Respect to a Measure.

Unit 4 (Sections: 6.1 to 6.5 of [1])

Inequalities and the L^p Spaces: The L^p Spaces - Convex Functions - Jensen's Inequality - The Inequalities of Holder and Minkowski - Completenessof$L^p(\mu)$.

Unit 5 (Sections: 8.1 to 8.4 of [1])
Signed Measures and their Derivatives: Signed Measures and the Decomposition - The Jordan Decomposition - The Radon-Nikodym Theorem - Some Applications of the Radon-Nikodym Theorem.

Course Outcomes

CO -01: To understand the notion of measure of a set on the real line and the measurable sets and functions.
CO-02: To understand the notion of Lebesgue Integrals as a generalization of Riemann Integrals.
CO-03: To understand abstract measure spaces and integration with respect to a measure.
CO-04: To understand and apply various inequalities to establish the completeness of $?^?(?)$.
CO-05: To understand Raydon-Nikodym Theorem its Applications

TEXT BOOK:

1. *Measure Theory and Integration by G.de Barra. First Edition. New Age International Publishers, Reprint 2000.*
2.

REFERENCE BOOKS:

1. *Real Analysis by H.L. Royden and P.M. Fitzpatrick. Fourth Edition. Pearson Education Asia Limited, 2010.*
2. *Elias M. Stein & Rami Shakarchi***,** *Real Analysis Measure Theory, Integration, and Hilbert Spaces (Princeton Lectures in Analysis), Princeton university press, 2007.*

18MAT515 NUMERICAL ANALYSIS 3 0 0 3

Prerequisites: Calculus and Algebra

Unit I:

Review of errors and error propagation theorem;
(Roots of Transcendental and Polynomial Equations, Solution of equations in one variable: Rate of convergence for fixed point iteration method and Newton-Raphson method etc.;
System of nonlinear equations: Newton's Method, Steepest-Descent Method; (B1-10.2 and 10.4)
Solution of System of Linear Algebraic Equations: Decomposition method (LU), Ill-conditioned system, Iteration methods: Gauss-Jacobi method, Gauss- Seidel method; (B2-2.2, B2-2.4, B2-2.5)
Eigenvalues and Eigenvectors: Ghershgorin theorem, Inverse power method. (B1-7.2, B3-3.6) **12 Hours**

Unit II:

Interpolation, Extrapolation and Approximation: Interpolating polynomials using finite differences, Hermite interpolation, Cubic-Spline interpolation, Richardson's Extrapolation. (B1-3.3, B1-3.4, B1-3.5, B1-4.2)
Numerical Differentiation: Numerical differentiation (Methods based on Interpolation, Finite difference operators, undetermined co-efficient); (B3-5.2)
Numerical integration: Trapezodial, Simpson's 1/3rd, 3/8th rule, Gaussian Quadrature, Multiple integrals. (B1-4.3) **10 Hours**

Unit III:

Solutions of Ordinary Differential Equations: System of higher order differential equations, Stability, Stiff Differential equations; (B1-5.9, B1-5.10, B1-5.11)
Boundary value Problems of ODE: Shooting Method (B1-11.1, B1-11.2). **8 Hours**

Unit IV:

Solutions of Differential equations: Introduction to Finite element method: Mathematical Background, Finite Elements for ordinary differential equations, Finite Elements for ordinary differential equations, (B2-9.1, 9.2). **10 Hours**

Unit V:

Finite Elements for partial differential equations: Heat equations (Parabolic and Elliptic PDE) and Wave equations (Hyperbolic PDE) (B2- 9.3). **10 Hours**

<u>Course Outcomes</u>

CO-1: Root finding techniques for algebraic and transcendental equations, system of equations.
CO-2: Understand the concepts of interpolation and extrapolation, and construction of polynomials.
CO-3: Application of numerical methods to understand the concept of numerical differentiation and integration and implementation of shooting method to solve Boundary value problems.
CO-4: Application of finite element method to solve second order PDEs.
CO-5: Usage of software tools to solve various problems numerically.

TEXT BOOKS:

1. R.L. Burden, J. D. Faires, Numerical Analysis, Richard Stratton, 2011, 9th edition.
2. C. F. Gerald, P.O. Wheatley, Applied Numerical Analysis, Pearson Publishers, 2013, 7th Ed
3. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical methods for scientific and Engineering computation, New Age International Publishers, 2007, 5th edition.

REFERENCE BOOKS:

1. E. Kreyszig, Advanced Engineering Mathematics, Wiley Publishers, 2015, 10th edition.
2. R.R. Bhat, S. Chakraverty, Numerical Analysis in Engineering, Narosa Publishing House, 2011.

18MAT582 Numerical Computations Lab 0 0 2 1

Finite Element Methods using MAT LAB or Finite element tools.

18MAT601 Advanced Graph Theory 3 1 0 4

Unit 1

Review of Graphs: Graphs and Sub graphs, isomorphism, matrices associated with graphs, degrees, walks, connected graphs, shortest path algorithm.
Trees: Trees, cut-edges and cut-vertices, spanning trees, minimum spanning trees, DFS, BFS algorithms.

Unit 2

Connectivity: Graph connectivity, k-connected graphs and blocks.
Euler and Hamilton Graphs: Euler graphs, Euler's theorem. Fleury's algorithm for Eulerian trails. Necessary / sufficient conditions for the existence of Hamilton cycles, Chinese-postman problem, approximate solutions of traveling salesman problem

Unit 3

Matching: Matchings, maximal matchings. Coverings and minimal coverings. Berge's theorem, Hall's theorem, Tutte's perfect matching theorem, Job assignment problem.
Coverings, Independent Sets and Cliques; Basic Relations.

Unit 4

Colorings: Vertex colorings, greedy algorithm and its consequences, Brooks' theorem. Edge-colorings, Vizing theorem on edge-colorings.

Unit 5

Planar graphs: Euler formula. Dual graphs. Kuratowaski's Characterization, Planarity testing algorithm.

Course Outcomes

CO-1: Understand the basic concepts of graphs and trees.
CO-2: Understand and apply the concepts of graph connectivity and shortest path problems.
CO-3: Understand and apply the concepts of matching problems in job assignments.
CO-4: Understand the concepts of vertex and edge colorings.
CO-5: Understand the concepts of planar graphs and dual graphs.

TEXT BOOKS

J.A. Bondy and U.S.R. Murty, Graph Theory and Applications, Springer, 2008.

REFERENCES BOOKS

1. *D.B. West, Introduction to Graph Theory, P.H.I. 2010.*
2. *Frank Harary, Graph Theory, New York Academy of Sciences, 1979.*
3. *Russel Merris, Graph Theory, John Wiley, 2011.*

18MAT602 FUNCTIONAL ANALYSIS 3 1 0 4

Unit 1(Sections: 3.1 to 3.5 of [1])
Normed Linear Spaces: Linear Spaces – Normed Linear Spaces – The Metric on a Normed Linear Space – Linear Subspaces – Bounded Linear Transformations.

Unit 2(Sections: 3.7 to 3.9 and 4.1 to 4.2 of [1])
Linear Homeomorphisms – An Elementary Integral – Regulated Mappings – Integration and Differentiation - Review of Compact Metric Spaces – Basic Results on Compact Subsets of a Metric Space – Separability of Compact Metric Spaces – Conditions Equivalent to Compactness - Borel – Lebesgue Theorem.

Unit 3(Sections: 4.3 to 4.6 of[1])
Compactness and Continuity – Dini's Theorem - Finite Dimensional Normed Linear Spaces – Completeness – Stone Weierstrass Theorem – Weierstrass Theorem on approximation of periodic functions by trigonometric polynomials – Extension of Stone-Weirstrass Theorem to $C_c(X)$ - Separability of $C_K(X)$ - Ascoli-Arzela Theorem – Peano's Theorem.

Unit 4(Sections: 5.1 to 5.4 of [1])
Bounded Linear Functionals – Some Dual Spaces – The Hahn-Banach Theorem – The Existence of Bounded Linear Functionals – Reflexivity of the Banach Space l^p - Annihilators.

Unit 5(Sections: 5.5 to 5.7 of[1])
A Theorem on Convex Sets – The Riesz Representation Theorem – Hergoltz's Theorem.

Course Outcomes

CO1: To understand the concepts of linear space, metric space and normed linear space. To analyze the spaces which has both linear structure and metric structure.To apply this new structure on set of all transformations and operators, so that continuity and boundedness becomes equivalent. By applying these results, we obtain a new normed spaces of all bounded linear transformations.

CO2: To understand and review the concepts from real analysis such as Integration and Differentiation, Compact Spaces and separability of compact metric Spaces. To apply and evaluate the corresponding results in this normed spaces.

CO3: To understand finite dimensional normed spaces and operators on it. To understand and apply Stone Weierstrass Theorem, Ascoli-Arzela Theorem and Peano's Theorem.

CO4: To understand dual spaces and reflexive spaces. To understand and apply Hahn Banach Theorem.

CO5: To understand convex sets. To understand and apply The Riesz Representation Theorem and Hergoltz's Theorem.

TEXT BOOK:

Elements of Functional Analysis by A.L. Brown and A. Page, Van Norstrand Reinhold Company, London,1970.

REFERENCES BOOKS:

1. Functional Analysis by Balmohan V Limaye, New Age International Publishers, Third Ed, Reprint 2014.
2. Introduction to Topology and Modern Analysis by G. F. Simmons, McGraw Hill Education, 2004
3. Thamban Nair, Functional Analysis: A First Course, PHI, 2001.

18MAT603 **Basics of Fluid Dynamics** **3 1 0 4**

Unit 1

Kinematics of Fluids in motion – Lagrangian and Eulerian methods – Equation of continuity – Boundary conditions – Kinematic and physical – steam line, path line and streak line – velocity potential – vorticity - rotational and irrotational motion.

Unit 2

Equation of Motion of Compressible Viscous Fluid (Navier-Stokes Equations) - General Properties – Equation of motion of inviscid fluid – Euler's equation – impulsive force – physical meaning of velocity potential - energy equation.

Unit 3

Lagrange's hydrodynamical equations - Bernoulli's equation and its applications - Motion in two-dimensions and sources and sinks – irrotational motion – complex potential - Milne-Thomson circle theorem – Blasius theorem.

Unit 4

General theory of irrotational motion – flow and circulation – Stoke's theorem – Kelvin's Circulation theorem – Permanence of irrotational motion - Kelvin's minimum energy theorem - Viscous Incompressible flow - Dimensional Analysis – Buckingam π theorem.

Unit 5

Exact Solutions of Navier Stokes Equations – Small Reynold's number flows – flow past a sphere – Stokes flow – Whitehead's paradox - Flow past a circular cylinder – Stoke's Paradox.

<u>Course Outcomes</u>

CO- 01: To understand the Lagrangian and Eulerian frames of references, to apply mass conservation to derive Equation of Continuity and to familiarize basic ideas in fluid motion.
CO-02: To apply principles of momentum conservation and energy conservation to derive Equation of Motion and Equation of Energy.
CO-03 : To understand two dimensional fluid flow and to understand Milne-thomson Circle Theorem and Blasius Theorem.
CO - 04: To understand general theory of irrotational theorem and Kelvin's theorem on permancence of irrotation motion.
CO-05: To apply the equations of motion to to find closed form solutions of simple flow problems and to understand the limitations of the theory through simple paradoxes.

TEXT BOOKS / REFERENCES BOOKS:

1. *G.K.Batchelor, "An Introduction to Fluid Dynamics", Cambridge University Press, 1997.*
2. *L.M. Milne-Thompson, "Theoretical Hydrodynamics", Dover Publications, 1968.*
3. *Victor L. Streeter and E. Benjamin Wylie, "Fluid Mechanics", Mc Graw Hill, 1983.*
4. *S.W. Yuan, "Foundations of Fluid Mechanics", Prentice Hall, New Jersey, 1970.*

18MAT611 Operator Theory 4 0 0 4

Compact operators on Hilbert Spaces. (a) Fredholm Theory (b) Index, $C*$- algebras - noncommutative states and representations, Gelfand-Neumark representation theorem, Von-Neumann algebras; projections, double commutant theorem, $L\infty$ functional calculus, Toeplitz operators.

<u>Course outcomes</u>

CO1: To understand compact operators and apply in Fredholm Theory and $C*$- algebras.

CO2: To understand and apply Gelfand-Neumark representation theorem.

CO3: To understand and apply projections, Toeplitz operators.

REFERENCE BOOKS:

1. W. Arveson, “An invitation to C*-algebras”, Graduate Texts in Mathematics, No. 39. Springer-Verlag, 1976.
2. N. Dunford and J. T. Schwartz, “Linear operators. Part II: Spectral theory. Self adjoint operators in Hilbert space”, Interscience Publishers John Wiley i& Sons 1963.
3. R. V. Kadison and J. R. Ringrose, “Fundamentals of the theory of operator algebras. Vol. I. Elementary theory”, Pure and Applied Mathematics, 100, Academic Press, Inc., 1983.
4. V. S. Sunder, “An invitation to von Neumann algebras”, Universitext, Springer-Verlag, 1987.

18MAT696 DISSERTATION 10 cr

Every student is required to register for a project under a faculty member, within or outside the Department. At the completion of the Project work, the student will submit a bound volume of the project report in the prescribed format. The project work will be evaluated by a team of duly appointed examiners. The evaluation is based on contents, presentation and viva-voce.

Course Outcomes

CO-1: Identify and understand some open problems for the dissertation
CO-2: Use various mathematical concepts / theorems for research problems
CO-3: New proofs / methods / algorithms / solutions of the research problems.
CO-4: Presentation and documentation of the research findings.

ELECTIVES

18MAT631 ALGEBRAIC GEOMETRY 3 0 0 3

Unit 1 AFFINE AND PROJECTIVE VARIETIES
Noetherian rings and modules; Emmy Noether's theorem and Hilbert's Basissatz; Hilbert's Nullstellensatz; Affine and Projective algebraic sets; Krull's Hauptidealsatz; topological irreducibility, Noetherian decomposition; local ring, function field, transcendence degree and dimension theory; Quasi-Compactness and Hausdorffness; Prime and maximal spectra; Example: linear varieties, hypersurfaces, curves.

Unit 2 MORPHISMS
Morphisms in the category of commutative algebras over a commutative ring; behaviour under localization; morphisms of local rings; tensor products; Product varieties; standard embeddings like the segre- and the d-uple embedding.

Unit 3 RATIONAL MAPS
Relevance to function fields and birational classification; Example: Classification of curves; blowing-up.

Unit 4 NONSINGULAR VARIETIES
Nonsingularity; Jacobian Criterion; singular locus; Regular local rings; Normal rings; normal varieties; Normalization; concept of desingularisation and its relevance to Classification Problems; Jacobian Conjecture; relationships between a ring and its completion; nonsingular curves.

Unit 5 INTERSECTIONS IN PROJECTIVE SPACE
Notions of multiplicity and intersection with examples.

Course outcomes

CO 1: To understand the various structures introduced in Algebraic geometry and to prove the standard theorems due to Hilbert/Krull/Noether which give correspondence between algebraic varieties and ideals, rings and fields.

CO 2: To understands properties of morphisms and its applications

CO 3: To familiarize the concept of rational maps

CO 4: To identify nonsingualrity through various criteria and understand the process of   desingularisation

CO 5: To familiarize the idea of multiplicity and intersection with examples.

TEXTBOOKS / REFERENCES BOOKS

1. Robin Hartshorne, Algebraic Geometry, Graduate Texts in Mathematics (GTM) 8th Printing, Springer, 1997.
2. C. Musili, Algebraic Geometry for Beginners, Texts and Readings in Mathematics 20,   Hindustan Book Agency, 2001.

18MAT633   ALGEBRAIC TOPOLOGY   3 0 0 3

Unit 1

Geometric Complexes and Polyhedra: Introduction. Examples. Geometric Complexes and Polyhedra; Orientation of geometric complexes.
Simplicial Homology Groups: Chains, cycles, Boundaries and homology groups, Examples of homology groups; The structure of homology groups.

Unit 2
The Euler Poincare's Theorem; Pseudomanifolds and the homology groups of Sn. [Chapter 1 Sections 1.1 to 1.4 & Chapter 2 Sections 2.1 to 2.5 from the text].

Unit 3

Simplicial Approximation: Introduction; Simplicial approximation; Induced homomorphisms on the Homology groups; The Brouwer fixed point theorem and related results;

Unit 4

The Fundamental Group: Introduction; Homotopic Paths and the Fundamental Group; The Covering Homotopy Property for S1;
[Chapter 3 Sectins 3.1 to 3.4; Chapter 4 Sections 4.1 to 4.3]

Unit 5

Examples of Fundamental Groups; The Relation Between H1(K) and p1(iKi); Covering Spaces: The definition and some examples. Basic properties of covering spaces. Classification of covering spaces. Universal covering spaces. Applications.
[Chapter 4: Sections 4.4, 4.5; Chapter 5 Sections 5.1 to 5.5 from the text]

<u>Course Outcomes</u>

CO 1: To understand the concept complexes define homology groups

CO 2: To obtain homology groups for various pseudo manifolds

CO 3: To prove Brouwer fixed point theorem and understand its uses

CO 4: To familiarise the concept of homotopy theory and its role in topological spaces

Co 5: To find out the fundamental groups of various spaces and anayse the topological structures.

TEXT BOOK

Fred H. Croom: Basic Concepts of Algebraic Topology, UTM, Springer, NY, 1978.

REFERENCES BOOKS:

1. *Eilenberg S and Steenrod N: Foundations of Algebraic Topology, Princetion Univ. Press, 1952.*
2. *S.T. Hu: Homology Theory, Holden-Day, 1965.*
3. *S.T. Hu: Homology Theory, Academic Press, 1959.*

18MAT634 CODING THEORY 3 0 0 3

Unit 1 Introduction to linear codes and error correcting codes. Encoding and decoding of a linear code,

Unit 2 Dual codes. Hamming codes and perfect codes.

Unit 3 Cyclic codes. Codes with Latin Squares, Introduction to BCH codes.

Unit 4 Weight ennumerators and MDS codes.

Unit 5 Linear coding theory problems and conclusions.

Course Outcomes

CO-1: To understand the basic concepts of linear/error correcting codes and apply the concepts to encode and decode the information.
CO-2: To understand the concepts of dual /Hamming codes and apply the concept to find the parameters of given codes and their dual codes using standard matrix and polynomial operations **.**
CO-3: To familiarise the concepts of cyclic/BCH codes with required properties.
CO-4: To understand the concepts of weight enumerators and apply to find the weight information of the code.
To familiarise the concept of MDS code.
CO-5: Apply the basic concepts of linear codes to solve problems .

TEXT BOOKS:

1. *Raymond Hill, A first course in Coding Theory, Clarandon Press, Oxford (1986).*
2. *J.H. Van Lint, Introduction to Coding Theory, Springer (1998).*

REFERENCES

1. *W. Cary Huffman and Versa Pless, Fundamentals of Error Correcting Codes, Cambridge University Press (2003).*
2. *W.W. Peterson, Error Correcting Codes, Cambridge, MA MIT Press (1961).*
3. *V. Pless, W.C. Huffman and R.A. Brualdi, An Introduction to Algebraic Codes, in Hand book of coding theory, Eds. Amsterdam Elsevier (1998).*

18MAT635 COMMUTATIVE ALGEBRA 3 0 0 3

Unit 1 Rings and ideals, modules and operations on them (tensor product, Hom, direct sum and product).

Unit 2 Rings and modules of Fractions, primary decomposition.

Unit 3 Integral dependence and Valuations, Chain Conditions.

Unit 4 Noetherian Rings and Artin Rings.

Unit 5 Discrete valuation Rings and Dedekind Domains, Dimension theory.

Course Outcomes

CO-1: To understand the basic definitions of rings, ideals and modules through examples; To construct new modules by tensor product, Hom, direct sum/product.

CO-2: To understand the fractions of modules and apply the fractions to construct the field from integral domain. To familiarize the decomposition of rings/modules.

CO-3: To familiarize the concept of integral dependence of extension ring and chain conditions of modules. To understand the definitions of valuations / Noetherian / Artin rings through examples.

CO-4: To study the basic properties of Noetherian/Artin rings; use the basic properties to characterize/decompose the Noetherian/Artin rings.

CO-5: To understand the basic definitions of discrete valuation rings and Dedekind domains. To familiarize the concept of dimension theory of rings/modules.

TEXT BOOKS / REFERENCES

1. Atiyah-Macdonald, Commutative Algebra, Westview Press, 1994.
2. Zariski and Samuel, Commutative Algebra I, II , Springer, 1991.
3. Eisenbud, Commutative Algebra with a View Towards Algebraic Geometry, Springer, 1995.
4. Bourbaki, Commutative Algebra, Springer, 1989.

18MAT636 LIE ALGEBRA 3 0 0 3

Unit 1 Basic Concepts - Definition and Examples, Lie Algebra of Derivations, Adjoint Representation, Structure Constants, Direct Sums, Homomorphism and Isomorphisms, Ideals, Centre and Derived Algebra of a Lie Algebra, Simple Lie Algebras, The Normalizer of a Subalgebra and Centralizer of a Subset in Lie Algebras, Automorphism and Inner Automorphism of a Lie Algebra. (Book 1, Chapters 1 and 2).

Unit 2 Descending Central Series of a Lie Algebra, Nilpotent Lie Algebras. Derived Series of a Lie Algebra, Radical of a Lie Algebra, Solvable Lie Algebras, Engel's Theorem. (Book 1, Chapter 3).

Unit 3 Semisimple Lie Algebras - Theorems of Lie and Cartan, Jordan-Chevalley Decomposition, Cartan's Criterion. (Book 1, Chapter 4)

Unit 4 Killing Form, Inner Derivations, Abstract Jordan Decomposition, Complete Reducibility of Lie algebras. (Book 1, Chapter 5)

Unit 5 The Weyl Group, Root Systems. (Book 1, Chapter 10)

Course Outcome

CO 1: To understand the concept of Lie algebra and to know the substructures and operations on them.

CO 2: To familiarize nilpotent and solvable Lie algebras and prove the Engel's theorem

CO 3: To understand theorems on Semi simple Lie algebras and their applications .

CO 4: To derive various decomposition theorems on Lie algebras

Co 5: To understand the classification of Lie algebras through Dynkin diagrams

TEXT BOOKS / REFERENCES BOOKS

1. Jacobson, Lie Algebras, Dover, 1979.
2. J.P. Serre, Lie Algebras and Lie Groups, Benjamin, 1965 (Translated from French).
3. J.E. Humphreys, Introduction to Lie Algebras and Representation Theory, Springer-Verlag, 1980.

18MAT637 THEORY OF MANIFOLDS 3 0 0 3

Unit 1

Definition of Manifolds, Differentiable and Analytic Manifolds, Examples of Manifolds, Product of Manifolds, Mappings between Manifolds, Submanifolds, Tangent Vectors.

Unit 2

Differentials, The Differential of a Function, Infinitesimal Transformation, Tangent Space, Tangent Vector.

Unit 3

Cotangent Space, Vector Fields, Smooth Curve in a Manifold. Differential Forms– k-forms, Exterior Differential, its Existence and Uniqueness.

Unit 4

Exact Differential Forms. De Rham Cohomology Group, Betti Number, Poincare's Lemma, Inverse Function Theorem, Implicit Function Theorem and its Applications, Integral Curve of a Smooth Vector Field.

Unit 5

Orientable Manifolds– Definition and Examples. Smooth Partition of Unity– Definition and Existence. Riemannian Manifolds– Definition and Examples.

<u>Course Outcomes</u>

CO 1: To familiarize the concept of manifolds and learn their properties
CO 2: To understand the concept of tangent spaces and its properties
CO 3: To generalize the ideas of curves/derivatives to manifolds
CO 4: To prove the inverse /implicit function theorems in manifolds
Co 5: To understand Riemannian manifolds and their relevance

TEXTBOOKS / REFERENCES:

1. *P.M.Cohn, "Lie Groups", Cambridge University Press, 1965.*
2. *Claude Chevalley, "Theory of Lie Groups", Fifteenth Reprint, Princeton University Press, 1999.*

18MAT638 Linear Algebra and its Applications 3 0 0 3

Unit 1 Review: Vector Spaces.
Inner Products, Angle and Orthogonality in Inner Product Spaces, Length of a Vector, Schwarz Inequality, Orthogonal Vectors, Orthogonal Complement, Orthogonal Bases: Gram-Schmidt Process. **(Sec. 4.4)**

Unit 2 The Algebra of Linear Transformations, Characteristic Roots, Invertible Linear transformations, Characteristic Roots, Characteristic Vector, Minimal Polynomial, Matrices, Matrix of a Linear Transformation. **(Sec. 6.1 to 6.3).**

Unit 3 Canonical Forms: Triangular, Nilpotent Transformations, Jordan and Rational Canonical Form, invariant subspaces, cyclic subspaces.
(Sec. 6.4 to 6.6).

Unit 4 Trace and Transpose, Determinants, Symmetric and Skew Symmetric Matrices, Adjoint and Hermitian Adjoint of a Matrix, Hermitian, Unitary and Normal Transformations, Self Adjoint and Normal Transformations. **(Sec. 6.8 to 6.10)**

Unit 5 Problems in Eigen Values and Eigen Vectors, Diagonalization, Orthogonal Diagonalization, Quadratic Forms, Diagonalizing Quadratic Forms, Conic Sections. **(Sec. 7.1 to 7.3 and 9.5 to 9.6 from Reference Book 2)**

Course Outcomes

CO-1: To understand inner products and compute the angle/length of a vector. To apply Gram-Schmidt process to construct the orthonormal basis.

CO-2: To familiarize the concept of characteristic roots/ vectors and related properties. To apply the link between linear transformation and matrix to find characteristic roots/ vectors.

CO-3: To understand the construction of matrices for a linear transformation in the triangular/Jordan form. To apply the canonical form to find the rank of the matrix/transformation.

CO-4: To familiarize the types of matrices, understand their properties and apply them in transformation.

CO-5: To understand the process of diagonalizing and apply diagonalization to identify Conic Sections.

TEXT BOOK:

1. I. N. Herstein, 'Topics in Algebra', Second Edition, John Wiley and Sons, 2000.

REFERENCES:

1. David C. Lay, Linear Algebra and its Applications, Pearson.
2. Gilbert Strang,' Linear Algebra and its Applications, Fourth Edition, Cengage Learning, 2014.
3. Howard Anton and Chris Rorres, 'Elementary Linear Algebra', 9th Edition, Wiley, 2005.
4. Nabil Nassif, Jocelyne Erhel, Bernard Philippe, Introduction to Computational Linear Algebra, CRC press, 2015.

18MAT651 QUEUING THEORY AND INVENTORY CONTROL THEORY 3 0 0 3

Unit 1 Inventory concept – Components of Inventory model.

Unit 2 Deterministic Continuous Review model - Deterministic Periodic Review model.

Unit 3 The classical EOQ – Non zero lead time – EOQ with shortages allowed.

Unit 4 Deterministic Multiechelon Inventory models for supply chain management.

Unit 5 A stochastic continuous review model – A stochastic single period model for perishable products.

Course Outcomes

CO1 Understand the Inventory Concepts and study further the components of Inventory control
CO2 Understand the Deterministic Continuous Review model and Deterministic Periodic Review model.
CO3 Understand the classical EOQ , Non zero lead time and EOQ with shortages allowed
CO4 Understand the Deterministic Multiechelon Inventory models for supply chain management
CO5 Understand the stochastic continuous review model, A stochastic single period model for perishable products.

TEXT BOOKS

1. F S Hillier and Gerald J Lieberman, Introduction to Operations research, 8th edition, McGraw Hill.
2. Ravindran, Phillips and Solberg, Operations research Principles and Practice, 2nd Edition, John Wiley & Sons.

18MAT653 STATISTICAL PATTERN CLASSIFICATIONS 3 0 0 3

Unit 1 Introduction and Bayesian Decision Theory
Introduction – Pattern recognition systems – the design cycle – learning and adaptation – Bayesian decision theory – continuous features – Minimum error rate classification – discriminant functions and decision surfaces – the normal density based discriminant functions.

Unit 2 Maximum-likelihood and Bayesian Parameter Estimation
Maximum likelihood estimation – Bayesian estimation - Bayesian parameter estimation – Gaussian case and general theory – problems of dimensionality – components analysis and discriminants – hidden Markov models.

Unit 3 Nonparametric Techniques and Linear Discriminant Functions
Nonparametric techniques – density estimation – Parzen windows – nearest neighborhood estimation – rules and metrics – linear discriminant functions and decision surfaces – generalized linear discriminant functions – two-category linearly separable case – minimizing the perception criterion function.

Unit 4 Nonmetric methods and Algorithm-independent Machine Learning
Nonmetric methods – decision trees – CART methods – algorithm-independent machine learning – lack of inherent superiority of any classifier – bias and variance for regression and classification – resampling or estimating statistics – estimating and comparing classifiers.

Unit 5 Unsupervised Learning and Clustering
Unsupervised learning and clustering – mixture densities and identifiability – maximum likelihood estimates – application to normal mixtures – unsupervised Bayesian learning – data description and clustering – criterion functions for clustering – hierarchical clustering – component analysis – low-dimensional representations and multi-dimensional scaling.

Course Outcomes

CO1 To gain knowledge about pattern classification and dimensionality reduction method

CO2 To understand the use of Maximum-likelihood and Bayesian Parameter Estimation

CO 3 To understand and apply Nonparametric Techniques and Linear Discriminant Functions

CO4 To apply Nonmetric methods and Algorithm-independent Machine Learning

CO5 To implement clustering methods under unsupervised learning

TEXT AND REFERENCE BOOKS:

1. Richard O. Duda, Peter E. Hart and David G. Stork, Pattern Classification, Second Edition, 2003, John Wily & Sons.
2. Earl Gose, Richard Johnson baugh and Steve Jost, Pattern Recognition and Image Analysis, 2002, Prentice Hall of India.

18MAT654 STATISTICAL QUALITY CONTROL AND SIX SIGMA QUALITY ANALYSIS 3 0 0 3

Unit 1 Introduction to Quality Management – Japanese System of Total Quality Management.

Unit 2 Quality Circles - 7 Quality Control tools - 7 New Quality Control tools.

Unit 3 ISO 9000 Quality system Standards - Project Planning, Process and measurement system capability analysis - Area properties of Normal distribution.

Unit 4 Metrics of Six sigma, The DMAIC cycle - Design for Six Sigma - Lean Sigma – Statistical tools for Six Sigma.

Unit 5 Taguchi methods. Loss functions and orthogonal arrays and experiments.

<u>Course Outcomes</u>

CO1 To develop basic knowledge about TQM
CO2 To understand old and new quality improvement tools
CO3 To understand the aspects of project planning and capability analysis
CO4 To understand the concept of Six Sigma and Lean methods
CO5 To apply Taguchi methods

TEXT AND REFERENCE BOOKS

1. Ravichandran. J, Probability and Statistics for Engineers, 1st Edition 2012 (Reprint), Wiley India.
2. Montgomery Douglas C., Introduction to Statistical Quality Control, Sixth Edition. John Wiley & Sons, (2008).
3. Ishikawa K., Guide to Quality Control, 2nd Edition: Asian Productivity Organization, Tokyo (1983).
4. Taguchi G, Introduction to Quality Engineering: Designing Quality into Products and Processes Second Edition. (1991).
5. Harry, M and Schroeder R., Six Sigma: The Breakthrough Management Strategy. Currency Publishers, USA. (2000).

18MAT655 THEORY OF SAMPLING AND DESIGNS OF EXPERIMENTS 3 0 0 3

Unit 1

Stratified random sampling, estimation of the population mean, total and proportion, properties of estimators, various methods of allocation of a sample, comparison of the precisions of estimators under proportional allocation, optimum allocation and srs. Systematic sampling. Comparison of systematic sampling - srs and stratified random sampling for a population with a linear trend.

Unit 2

Unbiased ratio type estimators - Hartly-Ross estimator, regression method of estimation. Cluster sampling, single stage cluster sampling with equal and unequal cluster sizes, estimation of the population mean and its standard error. Two-stage cluster sampling with equal and unequal cluster sizes, estimation of the population mean and its standard error.

Unit 3

Unequal probability sampling, PPS sampling with and without replacement, cumulative total method, Lahiris method, Midzuno-Zen method, estimation of the population total and its estimated variance under PPS wr sampling, ordered and unordered estimators of the population total under PPS wor, Horwitz – Thomson estimator.

Unit 4

Elementary concepts (one and 2 way classified data) Review of elementary design (CRD, RBD, LSD) Missing plot technique in RBD and LSD with one and two missing values, Gauss-Markov theorem, BIBD: Elementary parametric relations, Analysis, PBIBD.

Unit 5

General factorial experiments, factorial effects, best estimates and testing the significance of factorial effects, study of 2^3 and 2^4 factorial experiments.

<u>Course Outcomes</u>

CO1 To develop basic knowledge about TQM
CO2 To understand old and new quality improvement tools
CO3 To understand the aspects of project planning and capability analysis
CO4 To understand the concept of Six Sigma and Lean methods
CO5 To apply Taguchi methods

TEXT AND REFERENCE BOOKS

1. Cochran, W.C. Sampling Techniques, Third Edition, Wiley Eastern, (1977).
2. Des Raj, Sampling Theory, Tata McGraw Hill, New Delhi, (1976).
3. Murthy, M.N., Sampling Theory, Tata McGraw Hill, New Delhi, (1967).

18MAT656 TIME SERIES ANALYSIS 3 0 0 3

Unit 1 Time series, components of time series, additive and multiplicative models, determination of trend, analysis of seasonal fluctuations.

Unit 2 Test for trend and seasonality, exponential and moving average smoothing, holt-winter smoothing, forecasting based on smoothing.

Unit 3 Time series as a discrete parameter stochastic process, auto covariance and auto correlation functions and their properties, stationary processes, test for stationarity, unit root test, stationary processes in the frequency domain, spectral analysis of time series.

Unit 4 Detailed study of the stationary processes: moving average (MA), autoregressive (AR), autoregressive moving average (ARMA) and autoregressive integrated moving average (ARIMA) models.

Unit 5 Estimation of ARMA models, maximum likelihood method (the likelihood function for a Gaussian AR(1) and a Gaussian MA(1)) and Least squares, Yule-Walker estimation for AR Processes, choice of AR and MA periods, forecasting, residual analysis and diagnostic checking.

<u>Course Outcomes</u>

CO1 To study different types of basic sampling methods
CO2 To understand the types of estimators and their applications
CO3 To understand with and without replacement sampling methods
CO4 To understand the use of sampling in experimental designs

CO5 To apply factorial experiments

TEXT BOOKS

1. Anderson, T.W. The Statistical Analysis of Time Series, John Wiley, New York, 1971.
2. Box, G.E.P. and Jenkins, G.M. Time Series Analysis- Forecasting and Control, Holden-day, San Francisco,1976.
3. Kendall, Sir Maurice and Ord, J.K., Time Series, Edward Arnold, London, 1990.

18MAT657 STATISTICAL TECHNIQUES FOR DATA ANALYTICS 3-0-0-3

Data Collection, classification and analysis - Sampling methods, classification of data and representation of data- bar and pie charts – histogram frequency polygon - Data Analysis Measures of Central tendency and dispersion - Mean, median, mode, absolute, quartile and standard deviations, skewness and kurtosis for both grouped and ungrouped data. Association of attributes.

Curve fitting and interpolation - Fitting of straight lines and curves - Correlation, regression, fitting of simple linear lines, polynomials and logarithmic functions - Interpolation and extrapolation methods - Binomial expansion, Newton and Gauss methods.

Index numbers and time series analysis - Types of index numbers, construction of index numbers such as simple aggregate, weighted aggregate index numbers, chain index numbers and consumer price indices - Time series and its components and computation of trends and variations - Seasonal variations - Trend analysis methods.

Decision analysis and Game theory - Payoffs, regrets, maximin and minimax criteria and loss and risks – Games – payoff matrix, saddle point, value of game and methods of solving – two-person-zero-sum games, dominance method, sub-game method

Course Outcomes

CO1 To understand data collection methods and to apply descriptive statistics to data
CO2 To understand and apply data fitting methods and analyze the outcomes
CO3 To analyse data using dimensionality reduction methods
CO4 To understand and apply clustering methods
CO5 To understand and apply nonmetric decision making methods

Text Books:

1. *Pillai R.S. N. andBagavathi. "Statistics", S. Chand, New Delhi, 2001.*
2. *Kanti Swarup, Gupta, P.K., and Man Mohan. "Operations Research" (Chapters 16 and 17), S. Chand, New Delhi, 2001.*

References Book

1. Amir D Aczel, Jayavel Soundarapandian , Palanisamy Saravanan, Rohit Joshi, Complete Business Statistics,7edition,McGraw Hill, New Delhi

18MAT671 DATA STRUCTURES AND ALGORITHMS 3 0 0 3

Unit 1 Introduction: growth functions – recurrence relation – methods – master method. Sorting: bubble – insertion sort – selection sort.

Unit 2 Divide and conquer: quick sort – merge sort – bucket sort – lower bounds – heap sort – comparisons of sorting.

Unit 3 Greedy algorithm: fractional knapsack problem – task scheduling problem. Dynamic programming: matrix multiplication problem – 0-1 knapsack.

Unit 4 Graph algorithms: graph traversal (DFS, BFS with analysis) – biconnected components – strong connectivity; shortest path algorithms (along with analysis) – Dijkstra – Bellman Ford – Floyd Warshall. All pairs shortest path algorithm – minimum spanning tree (with analysis) – Kruskal – Prim's – Baruvka's.

Unit 5
NP problems: definition, P, NP, NP complete, NP hard & co-NP, examples – P, NP.

Course Outcomes

CO-1: Understand the basic concepts of growth functions and various sortings.
CO-2: Understand and the concept of divide and conquer for various sortings.
CO-3: Understand and apply the greedy method for various problems.
CO-4: Understand various definitions of graphs and apply to some algorithms.
CO-5: Understand the concepts of various computational complexity classes.

TEXT BOOK

Goodrich M T and Tamassia R, Algorithm Design Foundations, Analysis, and Internet Examples, John Wiley and Sons, 2002.

REFERENCES

1. Baase S and Gelder A V, ``Computer Algorithms – Introduction to Design and Analysis, Pearson Education Asia, 2002.
2. Cormen T H, Leiserson C E, Rivest R L and Stein C, Introduction to Algorithms, Prentice Hall of India Private Limited, 2001.
3. Dasgupta S, Papadimitriou C and Vazirani U, Algorithms, Tata McGraw-Hill, 2009.
4. Horowitz E, Sahni S and Rajasekaran S, Fundamentals of Computer Algorithms, Galgotia, 1998.

18MAT672 ALGORITHMS FOR ADVANCED COMPUTING 3-0-0-3

Unit I

Issues regarding classification and prediction, Bayesian Classification, Classification by back propagation, Classification based on concepts from association rule mining, Other Classification Methods, Classification accuracy.

Unit II

Introduction to Decision trees - Classification by decision tree induction – Various types of pruning methods – Comparison of pruning methods – Issues in decision trees – Decision Tree Inducers – Decision Tree extensions.

Unit III

Introduction, Core text mining operations, Preprocessing techniques, Categorization, Clustering, Information extraction, Probabilistic models for information extraction

Unit IV

Soft Computing: Rationale, motivations, needs, basics: examples of applications in diverse fields, Basic tools of soft computing: Neural Networks, Fuzzy Logic Systems, and Support Vector Machines, Statistical Approaches to Regression and Classification - Risk Minimization, Support Vector Machine Algorithms.

Unit V

Single-Layer Networks: The Perceptron, The Adaptive Linear Neuron (Adaline) and the Least Mean Square Algorithm - Multilayer Perceptrons: The Error Backpropagation Algorithm – The Generalized Delta Rule, Heuristics or Practical Aspects of the Error Backpropagation Algorithm.

Course Outcomes

CO-1: Understand the various classifications
CO-2: Understand the concepts of decision trees
CO-3: Understand and apply the concepts preprocessing techniques for information extraction problems.
CO-4: Understand the concepts of various soft computing techniques.
CO-5: Understand the concepts of various algorithms in networks.

Text Books:

1. *Jiawei Han and Micheline Kamber, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, p3rd ed, 2010.*
2. *Jared Dean, "Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners", Wiley India Private Limited, 2014.*

References Books :

1. *LiorRokach and Oded Maimon, "Data Mining and Knowledge Discovery Handbook", Springer, 2nd edition, 2010.*
2. *Ronen Feldman and James Sanger, "The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data", Cambridge University Press, 2006.*
3. *Vojislav Kecman, "Learning and Soft Computing", MIT Press, 2010*.

18MAT673 COMPUTER AIDED DESIGN OF VLSI CIRCUITS 3 0 0 3

Unit 1

Introduction of Design Methodologies and Graph Theory: The VLSI Design Problems - Design Methods – Design Cycle – Physical Design Cycle - Design Styles.

Unit 2

Algorithmic and System Design - Structural and Logic Design - Layout Design. Graph terminologies – Data structures for the representation of Graphs – Algorithms: DFS – BFS - Dijkstra's shortest path algorithm – Prim's algorithm for minimum spanning trees. Combinatorial Optimization Problems – Complexity Class – P - NP Completeness and NP Hardness problems.

Unit 3

Placement, Partitioning and Floor Planning: Types of Placement Problems – Placement Algorithms – K-L Partitioning Algorithm. Optimization Problems in Floor planning - Shape Function and Floor plan Sizing.

Unit 4

Routing and Compaction: Types of Routing Problems – Area Routing – Channel Routing – Global Routings.

Unit 5

1D and 2D Compaction. Gete level – Switch level Modeling and Simulations.

Course Outcomes

CO-1: Understand the basic concepts of VLSI design problems.
CO-2: Understand various definitions of graphs and apply to some algorithms.
CO-3: Understand and apply the placement and partitioning algorithms.
CO-4: Understand and apply the routing algorithms.
CO-5: Understand the concepts of 1D and 2D compactions.

TEXT BOOK / REFERENCES:

1. *Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 2000.*
2. *Naveed Sherwani, "Algorithms for VLSI Physical Design Automation", Second Edition, Kluwer Academic Publishers, 1995.*
3. *Sadiq M Sait and Habib Youssef, "VLSI Physical Design Automation: Theory and Practice", IEET, 1999.*
4. *M. Sarrafzadeh and C. K. Wong, An Introduction to VLSI Physical Design, McGraw- Hill, New York, NY, 1996.*
5. *Giovanni De Micheli, Synthesis and Optimization of Digital Circuits, Tata McGraw Hill, 1994*

18MAT674 CRYPTOGRAPHY 3 0 0 3

Unit 1 **Classical ciphers:** Cryptanalysis of classical ciphers, Probability theory, Perfect security.
Block ciphers: DES, AES, Block cipher modes of operation.

Unit 2 **Private-key encryption:** Chosen plaintext attacks, Randomised encryption, Pseudorandomness, Chosen cyphertext attacks.

Unit 3 **Message authentication codes:** Private-key authentication, CBC-MAC, Pseudorandom functions, CCA-secure private-key encryption.

Unit 4 **Hash function:** Integrity, Pre-image resistance, 2nd pre-image resistance, Collision freeness.
Key distribution: Key distribution centres, Modular arithmetic and group theory, Diffie-Hellman key exchange.

Unit 5 **Public-key Distribution:** EIGamal encryption, Cramer-Shoup encryption, Discrete logarithm problem.
Digital Signatures: RSA signatures, RSA-FDH and RSA-PSS signatures, DSA signatures.

Course Outcomes

CO-1: Understand the basic concepts of classical ciphers.
CO-2: Understand the concepts of encryptions and pseudorandomness.
CO-3: Understand the concepts private-key encryption.
CO-4: Understand the concepts of EIGamal encryption.
CO-5: Understand the concepts of RSA and DSA signatures

TEXT / REFERENCE BOOKS:

1. Katz and Lindell, Introduction to Modern Cryptography. Second Edition, Chapman & Hall/ CRC Press, 2014.
2. Jonathan Katz and Yehuda Lindell, Introduction to Modern Cryptography, CRC Press.

3. Hans Delfs, Helmut Knebl, "Introduction to Cryptography, Principles and Applications", Springer Verlag.

18MAT675 FUZZY SETS AND ITS APPLICATIONS 3 0 0 3

Unit 1 Fuzzy Sets

Crisp Sets - an Overview, Fuzzy Sets - Definition and Examples, α - Cuts and its Properties, Representations of Fuzzy Sets, Extension Principles of Fuzzy Sets, Operations on Fuzzy Sets - Fuzzy Complements, Fuzzy Intersections, Fuzzy Unions, Combinations of Operations, Aggregation Operations.

Unit 2 Fuzzy Arithmetic

Fuzzy Numbers, Arithmetic Operations on Intervals, Arithmetic Operations on Fuzzy Numbers.

Unit 3 Fuzzy Relations

Binary Fuzzy relations, Fuzzy Equivalence Relations, Fuzzy Compatibility Relations.

Unit 4 Fuzzy Logic

Classical Logic, Multivalued Logic, Fuzzy Propositions, Fuzzy Quantifiers, Linguistic Hedges, Inference from Conditional Fuzzy Propositions, Conditional and Qualified Propositions and Quantified Propositions.

Unit 5 Uncertainty-based Information

Information and Uncertainty, Non Specificity of Crisp Sets – Non Specificity of Fuzzy Sets, Fuzziness of Fuzzy Sets, Uncertainty In Evidence Theory, Principles of Uncertainty.

Course Outcomes

CO-1: Understand the basic concepts of Fuzzy sets
CO-2: Understand the concepts of arithmetci operations on fuzzy numbers.
CO-3: Understand the concepts Fuzzy relations.
CO-4: Understand the concepts of Fuzzy logic.
CO-5: Understand the concepts of uncertainty and crisp sets.

TEXT AND REFERENCE BOOKS:

1. *George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic- Theory and Applications, Prentice Hall of India, 1997.*
2. *Timothy J. Ross, Fuzzy Logic with Engineering Applications, McGraw Hill, 1997.*
3. *H.J. Zimmermann, Fuzzy Sets and its Applications, Allied publishers, 1991.*

18MAT676 INTRODUCTION TO SOFT COMPUTING 3 0 0 3

Unit 1 Soft Computing

Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques, applications of soft computing.

Unit 2 Artificial Intelligence

Introduction, Various types of production systems, characteristics of production systems, breadth first search, depth first search techniques, other Search Techniques like hill Climbing, Best first Search, A* algorithm, AO* Algorithms and various types of control strategies.

Unit 3 Fuzzy Logic

Crisp set and Fuzzy set, basic concepts of fuzzy sets, membership functions. Basic operations on fuzzy sets, Properties of fuzzy sets, Fuzzy relations. Propositional logic and Predicate logic, fuzzy If - Then rules, fuzzy mapping rules and fuzzy implication functions, Applications.

Unit 4 Neural Networks

Basic concepts of neural networks, Neural network architectures, Learning methods, Architecture of a back propagation network, Applications.

Unit 5 Genetic Algorithms

Basic concepts of genetic algorithms, encoding, genetic modeling.
Hybrid Systems: Integration of neural networks, fuzzy logic and genetic algorithms.

Course Outcomes

CO-1: Understand the various types of soft computing techniques
CO-2: Understand the concepts of artificial intelligence.
CO-3: Understand and apply the concepts fuzzy logic in optimization problems.
CO-4: Understand the concepts of neural networks.
CO-5: Understand the concepts of genetic algorithms.

TEXT AND REFERENCE BOOKS

1. *S. Rajasekaran and G. A. Vijaylakshmi Pai. Neural Networks Fuzzy Logic, and Genetic Algorithms, Prentice Hall of India.*
2. *K. H. Lee. First Course on Fuzzy Theory and Applications, Springer-Verlag.*
3. *J. Yen and R. Langari. Fuzzy Logic, Intelligence, Control and Information, Pearson Education.*

18MAT677 OBJECT- ORIENTED PROGRAMMING AND PYTHON 3 0 0 3

Unit 1

Object-oriented programming concepts – objects – classes – methods and messages – abstraction and encapsulation – inheritance – abstract classes – polymorphism.

Introduction to C++ – classes – access specifiers – function and data members – default arguments – function overloading – friend functions – const and volatile functions - static members – Objects - pointers and objects – constant objects – nested classes – local classes.

Unit 2

Constructors – default constructor – Parameterized constructors – Constructor with dynamic allocation – copy constructor –destructors – operator overloading – overloading through friend functions – overloading the assignment operator – type conversion – explicit constructor.

Unit 3

Function and class templates - Exception handling try-catch-throw paradigm – exception specification – terminate and Unexpected functions – Uncaught exception.

Unit 4

Inheritance – public, private, and protected derivations – multiple inheritance - virtual base class – abstract class – composite objects Runtime polymorphism – virtual functions – pure virtual functions – RTTI – typeid – dynamic casting – RTTI and templates – cross casting – down casting.

Unit 5

Python Programming.

<u>Course Outcomes</u>

CO-1: Understand the various classes in C++
CO-2: Understand the concepts of constructors and operators in C++
CO-3: Understand and apply the concepts functions for some problems.
CO-4: Understand the concepts of RTTI typeid dynamic casting.
CO-5: Understand and practice the Python programming.

TEXT BOOK

1. B. Trivedi, "Programming with ANSI C++", Oxford University Press, 2007.

REFERENCES BOOKS

1. Ira Pohl, "Object Oriented Programming using C++", Pearson Education, Second Edition Reprint 2004.
2. S. B. Lippman, Josee Lajoie, Barbara E. Moo, "C++ Primer", Fourth Edition, Pearson Education, 2005.
3. B. Stroustrup, "The C++ Programming language", Third edition, Pearson Education, 2004.

18MAT641 FIXED POINT THEORY 3 0 0 3

Unit 1 Contraction Principle, and its variants and applications;

Unit 2 Fixed points of non-expansive maps and set valued maps, Brouwer-Schauder fixed point theorems,

Unit 3 Ky Fan Best Approximation Theorem, Principle and Applications of KKM - maps, their variants and applications.

Unit 4 Fixed Point Theorems in partially ordered spaces and other abstract spaces.

Unit 5 Application of fixed point theory to Game theory and Mathematical Economics.

<u>Course Outcomes</u>

CO-1: Understand and apply the concepts of fixed point theorems to prove the existence and uniqueness of solution to certain ordinary differential equations.

CO-2: To understand the existence and uniqueness of fixed point for non expansive and set valued mappings.

CO-3: To understand the existence of best approximation point for non expansive mapping and its applications.

CO-4: To understand the existence and uniqueness of fixed point for partially ordered metric space.

As an application, to prove the existence and uniqueness of solution for a periodic boundary value problem.

CO-5: Applying the fixed point theorems of multivalued mappings to demonstrate the conditions for existence of Nash equilibria in strategic games.

TEXTBOOKS / REFERENCES BOOKS

1. *M.A. Khamsi and W.A. Kirk, An Introduction to Metric Spaces and Fixed Point Theory, Wiley - Inter Sci. (2001).*
2. *Sankatha Singh, Bruce Watson and Pramila Srivastava, Fixed Point Theory and Best Approximation: The KKM - map Principle, Kluwer Academic Publishers, 1997.*
3. *Kim C. Border, Fixed Point Theorems with Applications to Economics and Game Theory, Cambridge University Press, 1985.*

18MAT642 FRACTALS 3 0 0 3

Unit 1 Classical Fractals, Self-similarity - Metric Spaces, Equivalent Spaces.

Unit 2 The Space of Fractals, Transformation on Metric Spaces.

Unit 3 Contraction Mapping and Construction of fractals from IFS.

Unit 4 Fractal Dimension, Hausdorff measure and dimension, Fractal Interpolation Functions.

Unit 5 Hidden Variable FIF, Fractal Splines, Fractal Surfaces, Measures on Fractals.

Course Outcomes

- CO1. Understand the basic concepts and structure of fractals .
- CO2. Understand the space of fractals and transformation on metric spaces.
- CO3. Understand the iterated function system with contraction mapping theorem.
- CO4. Apply fractal concepts to compute fractal dimension of sets and construct fractal interpolation functions.
- CO5. Understand the hidden variable fractal interpolation function, fractal splines and fractal surfaces.

TEXT BOOKS

1. *M.F. Barnsley, Fractals Everywhere, Academic Press, 1993.*
2. *P.R. Massopust, Interpolation and Approximation with Splines and Fractals, Oxford University Press, 2009.*
3. *K. Falconer, Fractal Geometry (Mathematical Foundations and Applications), John Wiley & Sons, 2003.*

REFERENCES

1. *P.R. Massopust, Fractal Functions, Fractal Surfaces and Wavelets, Academic Press, 1994.*
2. *Heinz-Otto Peitgen and Peter Richter, The Beauty of Fractals, Springer, 1986.*

3. Richard M. Crownover, Introduction to Chaos and Fractals, Jones and Bartlett Publishers, 1995.
4. Gerald A. Edgar, Measure, Topology and Fractal Geometry, Springer, 1990.
5. M.F. Barnsley, Superfractals, Academic Press, 2006.
6. B.B. Mandelbrot, The Fractal Geometry of Nature, Freeman, 1981.

18MAT643 HARMONIC ANALYSIS 3 0 0 3

Unit 1 Fourier series and integrals – Definitions and easy results – The Fourier transform – Convolution – Approximate identities – Fejer's theorem – Unicity theorem – Parselval relation – Fourier Stieltjes Coefficients – The classical kernels.

Unit 2 Summability – Metric theorems – Pointwise summability – Positive definite sequences – Herglotz;s theorem – The inequality of Hausdorff and Young.

Unit 3 The Fourier integral – Kernels on R. The Plancherel theorem – Another convergence theorem – Poisson summation formula – Bachner's theorem – Continuity theorem.

Unit 4 Characters of discrete groups and compact groups – Bochners' theorem – Minkowski's theorem.

Unit 5 Hardy spaces **-** Invariant subspaces – Factoring F and M. Rieza theorem – Theorems of Szego and Beuoling.

Course Outcomes

CO1. Understand the basic concepts of Fourier series, Fourier transforms and their related results.
CO2. Analyze the characters of discrete and compact groups with their related results.
CO3. Understand the concepts of Fourier integrals with their convergence results.
CO4. Understand the different summability and analyze the inequlity of Hausdroff and Young.
CO5. Understand the concepts of Hardy spaces and invariant subspaces and their results.

TEXT BOOK:

Content and Treatment as in Henry Helson, Harmonic Analysis, Hindustan Book Agency, Chapters 1.1 to 1.9, 2.1 to 3.5 and 4.1 to 4.3

18MAT644 NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS 3 0 0 3

Review of first order equations and characteristics.

Unit 1 Weak solutions to hyperbolic equations **-** discontinuous solutions, shock formation, a formal approach to weak solutions, asymptotic behaviour of shocks.

Unit 2 Diffusion Processes **-** Similarity methods, Fisher's equation, Burgers' equation, asymptotic solutions to Burgers' equations.

Unit 3 Reaction diffusion equations **-** traveling wave solutions, existence of solutions, maximum principles and comparison theorem, asymptotic behaviour.

Unit 4 Elliptic equations **-** Basic results for elliptic operators, eigenvalue problems, stability and bifurcation.

Unit 5 Hyperbolic system.

Course outcomes

CO1- Understand the general concept of weak solution and the criterion of having weak solution for hyperbolic equation.
CO2- Able to model the basic diffusion processes and understand the mathematical methods that are useful in studying the structure of their solutions.
CO3-Understand the existence and uniqueness of traveling wave solutions solutions.
CO4-Understand the concept of nonlinear eigenvalue problem the stability of equilibrium solutions for reaction-diffusion equation.
CO5-Understand the formulation of system of PDEs and their applications.

TEXT BOOK

J David Logan, An Introduction to Nonlinear Partial Differential Equations, John Wiley and Sons, Inc., 1994

18MAT645 WAVELETS ANALYSIS 3 0 0 3

Unit 1 Basic Properties of the Discrete Fourier Transform, Translation - Invariant Linear Transformations. The Fast Fourier Transform.

Unit 2 Construction of Wavelets on Z_N, The First Stage Construction of Wavelets on Z_N, The Iteration Step"s. Examples and Applications, $l2(Z)$

Unit 3 Complete Orthonormal Sets in Hilbert Spaces, $L_2([-\pi,\pi))$ and Fourier Series, The Fourier Transform and Convolution on $l_2(Z)$, First-Stage Wavelets on Z
The Iteration Step for Wavelets on Z , Implementation and Examples.

Unit 4 $L_2(R)$ and Approximate Identities, The Fourier Transform on R, Multiresolution Analysis and Wavelets,

Unit 5 Construction of Multiresolution Analyses, Wavelets with Compact Support and Their Computation.

Course Outcomes

CO1 Understand and apply the concepts of DFT and its significance in Engineering problems
CO2 Understand and apply the concept of first stage wavelet basis and iterative stages of wavelet bases in finite dimensional space.
CO3 Understand and apply the concept of first stage wavelet basis and iterative stages of wavelet bases in infinite dimensional space.
CO4 Understand the concepts of Fourier transform and MRA and the construction of wavelets and its applications.

TEXT BOOK:

Michael W. Frazier, An Introduction to Wavelets Through Linear Algebra, Springer, 1999.

REFERENCES:

1. *Daubechis, Ten Lectures on Wavelets, SIAM, 1992.*
2. *S. Mallat, A Wavelet Tour of Signal Processing, Elsevier, 2008.*

18MAT646 MATHEMATICAL PHYSICS 3 0 0 3

***Objective**: This course intends to introduce applications of various mathematical techniques to problems of Theoretical Physics. Examples could be chosen from all 4 traditional divisions of Modern Fundamental Theoretical Physics – Classical Mechanics, Electrodynamics, Quantum Mechanics and Statistical Physics.*

Unit 1

Vector calculus and applications in electromagnetic theory and fluid mechanics.

Unit 2

Introduction to tensor calculus: review of basics, index notation, tensors in physics and geometry, Levi-Civita tensor, transformations of vectors, tensors and vector fields, covariance of laws of physics.

Unit 3

Calculus of variations and extremal problems, Lagrange muItipliers to treat constraints, Introduction to the Lagrangian and Hamiltonian formulations of classical mechanics with applications.

Unit 4

Gamma and Beta functions, Dirac delta function, Special functions, Review of Legendre, Bessel functions and spherical harmonics (with applications to Quantum mechanics), series solutions, generating functions, orthogonality and completeness,

Unit 5

Applied linear algebra: Dirac notation, dual vectors, projection operators, symmetric hermitian, orthogonal and unitary matrices in physics, diagonalization, orthogonality and completeness of eigenvectors, spectral decomposition and representation, simultaneous diagonalization, normal matrices, applications to coupled vibrations, Schrodinger equation in matrix form.

Course Outcomes

CO1 Applying Vector Calculus in Electromagnetic Theory and Fluid Mechanics
CO2 Understand and apply the concept of tensors in physics and geometry and covariance of law of physics
CO3 Understand and apply the concept of calculus of variation in classical mechanics related problems
CO4 Apply the concepts of Gamma, Beta functions etc in Problems related to quantum mechanics

TEXT BOOKS:

1. *Arften and Weber, Mathematical Methods for Physics, Elsevier, 6th Ed., 2005.*
2. *Riley, Hobson and Bence, Mathematical Methods for Physics and Engineering, Cup, 3rd Edition, 2010.*

18MAT661 ADVANCED BOUNDARY LAYER THEORY 3 0 0 3

Unit 1

Introduction – limitations of ideal fluid dynamics – Importance of Prandtl's boundary layer theory - boundary layer equations in two dimensional flows – boundary layer flow over a flat plate – Blasius solution – Boundary layer over a wedge.

Unit 2

Energy integral equation for two-dimensional laminar boundary layers in incompressible flow – application of Von Karman's integral equations to boundary layer with pressure gradient.

Unit 3

Displacement, momentum, energy thickness – axially symmetric flows – momentum equation for laminar boundary layer by von Karman – Wall shear and drag force on a flat plate due to boundary layer – coefficient of drag. Boundary layer equations for a 2D viscous incompressible fluid over a plane wall – Similar solutions – Separation of boundary layer flow.

Unit 4

Hydromagnetic Boundary layers – Hartman Layer – MHD Blasius flow. Thermal boundary layers – thermal boundary layer equation in two dimensional flow – Thermal boundary layers with and without coupling of velocity and temperature field – forced convection in a laminar boundary on a flat plate.

Unit 5

Polhausen's method of exact solution for the velocity and thermal boundary layers in free convection from a heated plate – thermal energy integral equation. Boundary layer control using suction and injection.

Course Outcomes

CO1 To gain in-depth knowledge about time series and its components
CO2 To understand the smoothening concepts and the relevant tests.
CO3 To understand and apply the concepts of autocorrelation and autocovariance
CO4 To apply various types of autoregressive models
CO5 To understand the estimation procedures in time series

TEXT BOOKS / REFERENCES:

1. H.Schlichting and K.Gersten, "Boundary Layer Theory", Eighth Edition, Springer, 2000.
2. L. Rosenhead, "Laminar Boundary Layers", Dover, 1988.
3. G.K.Batchelor, "An Introduction to Fluid Dynamics", Cambridge University Press,1993.
4. P.H.Roberts , "An Introduction to MHD" , Longmans, 1967.

18MAT662 COMPUTATIONAL FLUID DYNAMICS 3 0 0 3

Unit 1

Review of Conservation equations for mass, momentum and energy; coordinate systems; Eulerian and Lagrangian approach, Conservative and non-conservative forms of the equations, rotating co-ordinates.

Unit 2

Classification of system of PDEs: parabolic elliptic and hyperbolic; Boundary and initial conditions; Overview of numerical methods; Review of Finite Difference Method, Introduction to integral method, method of weighted residuals, finite elements finite volume method & least square method.

Unit 3

Numerical Grid Generation: Basic ideas, transformation and mapping, unstructured grid generation, moving grids, unmatched meshes. Finite Volume Method: Basic methodology, finite volume discretization, approximation of surface and volume integrals, interpolation methods - central, upwind and hybrid formulations and comparison for convection-diffusion problem; Basic computational methods for compressible flows.

Unit 4

Advanced Finite Volume methods: FV discretization in two and three dimensions, SIMPLE algorithm and flow field calculations, variants of SIMPLE, Turbulence and turbulence modelling, illustrative flow computations.

Unit 5

Introduction to turbulence modelling, CFD methods for compressible flows.

Course Outcomes

CO-01: To review the conservation laws and to understand the Eulerian and Lagrangian approach to fluid flow problems
CO-02: To understand the classification of PDEs and to review Finite Difference, Integral, Weighted Residual and Finite Element and Finite Volume and Least Square Methods
CO-03: To understand the finite volume discretization method and to develop computational methods for compressible flows
CO-04: To learn advance notions of finite volume methods and apply SIMPLE algorithm for flow and model and solve turbulent flows
CO-05 : To learn CFD methods for compressible and turbulent flows

TEXT BOOKS / REFERENCE BOOKS:

1. Anderson D A, Tannehill J C, and Pletcher R H, Computational Fluid Mechanics and Heat Transfer, 2nd edition, Taylor & Francis, 1997.
2. Ferziger, J. H. and Peric, M., Computational Methods for Fluid Dynamics, 3rd edition, Springer. 2003.

18MAT663 FINITE ELEMENT METHOD 3 0 0 3

Unit 1 Finite Element Method: Variational formulation - Rayleigh-Ritz minimization - weighted residuals - Galerkin method applied to boundary value problems.

Unit 2 Global and local finite element models in one dimension - derivation of finite element equation.

Unit 3 Finite element interpolation - polynomial elements in one dimension, two dimensional elements, natural coordinates, triangular elements, rectangular elements, Lagrangian and Hermite elements for rectangular elements - global interpolation functions.

Unit 4 Local and global forms of finite element equations - boundary conditions - methods of solution for a steady state problem - Newton-Raphson continuation.

Unit 5 One dimensional heat and wave equations.

Course Outcomes

CO-1: Understand the basic concepts of weighted residue and energy methods.
CO-2: Understand the concepts of global and local finite element models and its derivations.
CO-3: Application of interpolation and various polynomials to model stiffness matrices.
CO-4: Application of global and local finite element models with boundary conditions in a steady state problem.
CO-5: Usage of finite element concept for one dimensional heat and wave equations.

TEXT AND REFERENCE BOOKS

1. *J.N .Reddy, An Introduction to the Finite Element Method, McGraw Hill, NY.*
2. *Chung, Finite Element Analysis in Fluid Dynamics, McGraw Hill Inc.*

18MAT664 MAGNETO-HYDRO DYNAMICS 3 0 0 3

Unit 1

Electromagnetic field equations – Maxwell's equations - Electromagnetic effects and the magnetic Reynolds number – induction equation. Alfven's Theorem – Ferraro's Law of irrotation – Electromagnetic stresses.

Unit 2

Magnetohydrostatics and steady states – Hydromagnetic equilibria and Force free magnetic fields — Chandrasekhar's theorem – General solution of force free magnetic field when**Error! Objects cannot be created from editing field codes.** is constant – Some examples of force free fields.

Unit 3

Steady laminar motion – Hartmann flow. Tensor electrical conductivity, Hall current and ion slip – simple flow problems with tensor electrical conductivity.

Unit 4

Magnetohydrodynamic waves - Alfven waves – Stability of hydromagnetic systems - Normal mode analysis - Squire's theorem – Orr-Sommerfield equation – Instability of linear pinch – Flute instability – A general criterion for stability.

Unit 5

Bernstein's method of small oscillations – Jeans Criterion for Gravitational stability – Chandrasekhar's generalization for MHD and rotating fluids.

Course Outcomes

CO-01 : To understand the basic electromagnetic equations, MHD equations, magnetic stresses, induction equations and Alfven's Theorem and its application to Ferraro's Law of Isorotation.
CO-02: To understand magnetohydro statics, force-free magnetic fields and Chandrasekhar's theorem on fields with ohmic dissipation.
CO-03: To understand the effect of transverse magnetic field on flow between parallel plates (Hartman Flow) and the Hall effects
CO-04: To understand Alfven Waves in Incompressible and Compressible Flows and to apply Squire' Theorem to develop Rayleigh's Stability Equation and Orr-Somerfield Equation for the viscous fluid
CO-05: To understand Bertein's method of small oscillations and Chandrasekhar's generalization of Jean's Criteria for gravitation stability.

TEXT BOOKS / REFERENCES:

1. Ferraro, V.C.A and Plumpton, C., "An Introduction to Magneto-Fluid Mechanics", Clarendon Press, Oxford, 1966.
2. M.R. Crammer, and Shi-I Pai, "Magneto-Fluid Dynamics for Engineers and Applied Physicists", Scripta Publishing Company, Washington, 1973.
3. P.H. Roberts, "An Introduction to Magnetohydrodynamics", Longmans, Green and Co, London, 1967.
4.S. Chandrasekhar, "Hydrodynamic and Hydromagnetic Stability", Dover Publications, 1981.

18MAT665 MATHEMATICAL FOUNDATIONS OF INCOMPRESSIBLE FLUID FLOW 3 0 0 3

Unit 1

Kinematics of Fluids in motion – Lagrangian and Eulerian methods – Equation of continuity – Boundary conditions – Kinematic and physical – steam line, path line and streak line – velocity potential – vorticity - rotational and irrotational motion.

Unit 2

Equation of Motion of Compressible Viscous Fluid (Navier-Stokes Equations) - General Properties – Equation of motion of inviscid fluid – Euler's equation – impulsive force – physical meaning of velocity potential - energy equation.

Unit 3

Lagrange's hydrodynamical equations - Bernoulli's equation and its applications - Motion in two-dimensions and sources and sinks – irrotational motion – complex potential - Milne-Thomson circle theorem – Blasius theorem.

Unit 4

General theory of irrotational motion – flow and circulation – Stoke's theorem – Kelvin's Circulation theorem – Permanence of irrotational motion - Kelvin's minimum energy theorem - Viscous Incompressible flow - Dimensional Analysis – Buckingam**Error! Objects cannot be created from editing field codes.** theorem.

Unit 5

Exact Solutions of Navier Stokes Equations – Small Reynold's number flows – flow past a sphere – Stokes flow – Whitehead's paradox - Flow past a circular cylinder – Stoke's Paradox.

<u>Course Outcomes</u>

CO-01 : To understand the kinematics of fluid in motion, continuity equation, vorticity and rotational and irrotational motion
CO-02: To understand Equation of Motion of Compressible Viscous Fluid (Navier-Stokes Equations), Equation of motion of inviscid fluid – Euler's equation,energy equation.
CO-03: To learn Lagrange's hydrodynamical equations, Bernoulli's equation and its applications, Milne-Thomson circle theorem – Blasius theorem.
CO-04: To understand Stoke's theorem, Kelvin's Circulation theorem, Permanence of irrotational motion, Kelvin's minimum energy theorem and Dimensional Analysis – BuckingamError
CO-5: To learn exact Solutions of Navier Stokes Equations,various flows and Stokes paradox

TEXT BOOKS / REFERENCES:

1. G.K. Batchelor, "An Introduction to Fluid Dynamics", Cambridge University Press, 1997.
2. L.M. Milne-Thompson, "Theoretical Hydrodynamics", Dover Publications, 1968.
3. Victor L. Streeter and E. Benjamin Wylie, "Fluid Mechanics", Mc Graw Hill, 1983.
4. S.W. Yuan, "Foundations of Fluid Mechanics", Prentice Hall, New Jersey, 1970.

18MAT666 Introduction to FLUID DYNAMICS 3 0 0 3

Unit 1 Basic Concepts and Properties

Fluid – definition, distinction between solid and fluid - Units and dimensions – Properties of fluids – density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillary and surface tension – Fluid statics: concept of fluid static pressure, absolute and gauge pressures – pressure measurements by manometers and pressure gauges.

Unit 2 Fluid Kinematics

Fluid Kinematics - Flow visualization - lines of flow - types of flow - velocity field and acceleration - continuity equation (one and three dimensional differential forms)- Equation of streamline - stream function - velocity potential function - circulation - flow net –

Unit 3 Fluid Dynamics

Fluid dynamics - equations of motion - Euler's equation along a streamline - Bernoulli's equation – applications - Venturi meter, Orifice meter, Pitot tube - dimensional analysis - Buckingham's theorem - applications - similarity laws and models.

Unit 4 Incompressible Fluid Flow

Viscous flow - Navier - Stoke's equation (Statement only) - Shear stress, pressure gradient relationship - laminar flow between parallel plates - Laminar flow through circular tubes (Hagen poiseulle's).

Unit 5

Hydraulic and energy gradient - flow through pipes - Darcy-weisback's equation - pipe roughness - friction factor - Moody's diagram - minor losses - flow through pipes in series and in parallel - power transmission - Boundary layer flows, boundary layer thickness, boundary layer separation - drag and lift coefficients.

Course Outcomes

CO-1: To understand basics concepts & properties of fluids and fluid statics
CO-2 To understand the fluid kinematicies, continutiy equations, Stream line, steam function & velocity potential functions
CO-3 To understand the bacis concept of fluid dynamics
CO-4 To understand the bacis concept of incmpressible fluid flow
CO-5 To learn basics concepts of hydraulic & energy gradient & boundry layer force

TEXT BOOKS

1. Streeter, V.L., and Wylie, E.B., Fluid Mechanics, McGraw-Hill, 1983.
2. Kumar, K.L., Engineering Fluid Mechanics, Eurasia Publishing House (P) Ltd., New Delhi (7th Edition), 1995.

REFERENCE:

White, F.M., Fluid Mechanics, Tata McGraw-Hill, 5th Edition, New Delhi, 2003.

LANGUAGES

18HIN101 **HINDI I** **1-0-2[2cr]**

Unit-1

a)Introduction to Hindi Language, -other Indian Language's, Official Language, link Language Technical terminology..
b) Hindi alphabet: ParibhashaAurBhed.
c) Shabda: ParibhashaAurBhed, RoopantharkiDrishti se
d) Sangya -ParibhashaAurBhed,SangyakeRoopanthar-ling, vachan, karak
e) Sarvanaam- ParibhashaAurBhed.

Unit-2

a) Common errors and error corrections in Parts of Speech –with emphasis on use of pronouns, Adjective and verb in different tenses –gender& number
b) Conversations, Interviews, Short speeches.

Unit -3

a) Letter writing –ParibhashaAurBhed, Avedanpatra (request letter) & Practice
b) Translation-ParibhashaAurBhed, English to Hindi

Unit- 4

Peom :
a) Maithilisharangupth: sakhivemujsekahakarjaate
b) Suryakanthtripatinirala :Priyatam
c) Mahadevivarma- adhikaar
d) Shiyaramsharangupth:ekphoolkichah

Unit- 5

Kahani
a) Kafan - Premchand ,
b) Rajasthan ki Ek Gaav kee theerthyatra - Beeshmasahni
c) Raychandrabhai :By Mahathma Gandhi - Sathya ke prayog
d) Rajani - Mannu Bhandari

Course Outcomes

CO1: To understand the nature & culture of the language.
CO2: Ability to understand the structure of the language in different contexts. .
CO3: To understand the functional skills of the language.
CO4: Enhance the social contribution of modern literature.
CO5: Develop research and secondary reading ability.

18HIN111 HINDI II 1-0-2[2cr]

Unit -1

a) Visheshan- ParibhashaAurBhed.special usage of adverbs, changing voice and conjunctions in sentences.
b) kriya- ParibhashaAurBhed, rupantharkidrushti se-kaal
c) padhparichay.
d) Vigyapan Lekhan (Advertisement writing), Saar Lekhan (Precise writing).

Unit -2

Communicative Hindi – MoukhikAbhivyakthi –understanding proper pronunciation, Haptics …etc in Interviews ,short speeches .

Unit -3

Film review,Audio –Visual-Media in Hindi – Movies appreciation and evaluation.News reading and presentations in Radio and Tv channels in Hindi, samvaadhlekhan,

Unit -4

a) Harishankarparasaiyi- SadacharkaThavis
b) Jayashankarprasadh – Mamata
c) Mannubandari- Akeli
d) Habibtanvir- Karthus

Unit -5

Kavya Tarang

a) Himadri thung shrung se (poet- Jayasankar prasad)
b) Dhabba (poet- kedarnath sing) ,
c) Proxy (poet- Venugopal),
d) Machis(poet –Suneeta Jain) ,
e) Vakth. (poet – Arun kamal)
f) Fasal (poet- Sarveshwar Dayal Saxena)

Course Outcomes

CO1: Develop the creativity & language competence.
CO2: To improve the writing and analytical skillsTeaching
CO3: Enhancing critical thinking.
CO4: A good exposure with the different styles of literary writing.
CO5: To understand the post- modern trends of literature.

18KAN101 KANNADA I 1-0-2[2cr]

- To enable the students to acquire basic skills in functional language.
- To develop independent reading skills and reading for appreciating literary works.
- To analyse language in context to gain an understanding of vocabulary, spelling, punctuation and speech

UNIT – 1

- Railway Nildanadalli – K. S. Narasimha Swamy
- Amma, Aachara Mattu Naanu – K. S. Nisar Ahamad
- Kerege Haara – Janapada
- Simhaavalokana – H.S. Shivaprakash

UNIT – 2

- Dhanwantri Chikitse - Kuvempu
- Mouni - Sethuram
- Meenakshi Maneya Mestru - Kuvempu

UNIT – 3

- Sukha –H.G Sannaguddayya
- Mobile Thenkara Jen Nonagala Jhenkara – Nagesh Hegade
- Namma Yemmege Maatu Tiliyitu – Goruru Ramaswamy Iyangar

UNIT – 4

Language structure

- Usage of punctuation marks
- Introduction to words (right usage)
- Reading skills
- Sentence formation (simple & complex)
- Translation- English to Kannada

References:

1. Kannada Samskruti Kosha – Dr. Chi. C Linganna
2. Kannada Sanna Kathegalu – G H Nayak
3. Lekhana Kale – N. Prahlad Rao
4. Kannada Sahithya Charithre – R. Sri Mugali

18KAN111 **KANNADA II** **1-0-2[2cr]**

Objectives:

- To enable the students to acquire basic skills in functional language.
- To develop independent reading skills and reading for appreciating literary works.
- To develop functional and creative skills in language.
- To enable the students to plan, draft, edit & present a piece of writing.

UNIT – 1

- Bettada Melondu Maneya Maadi – Akka Mahadevi
- Thallanisadiru Kandya – Kanakadasa

- Avva – P. Lankesh
- Neevallave – K. S. Narasimha Swamy

UNIT – 2

Gunamukha – Drama by P. Lankesh

UNIT – 3

Karvalo – Novel by Poornachandra Thejaswi

UNIT – 4

Letter Writing –
Personal (congratulation, invitation, condolence etc.)
- Official (To Principal, Officials of various departments, etc.,)
- Report writing
- Essay writing
- Precise writing

Prescribed text:

1. Gunamukha by P. Lankesh (Lankesh Prakashana)
2. Karvalo by Poornachandra Thejaswi (Mehtha publishing house)

Reference

1. Saamanyanige Sahithya Charitre (chapter 1 to 10) – Bangalore University Publication
2. Hosa Kannada Saahithya Charithre – L.S Sheshagiri Rao
3. Kacheri Kaipidi – Kannada Adhyayana Samsthe (Mysuru University)
4. Kannada Sahithya Charithre – R. Sri Mugali
5. H.S.Krishna Swami Iyangar – *Adalitha Kannada – Chetana Publication, Mysuru*

18SAN101 SANSKRIT I 1-0-2[2cr]

To familiarize students with Sanskrit language and literature.

To read and understand Sanskrit verses and sentences.

Self-study of Sanskrit texts and to practice communication in Sanskrit.

To help the students imbibe values of life and Indian traditions propounded by the scriptures.

To be able to speak in Sanskrit.

Module I

Introduction to Sanskrit language, Devanagari script - Vowels and consonants, pronunciation, classification of consonants, conjunct consonants, words – nouns and verbs, cases – introduction, numbers, Pronouns, communicating time in Sanskrit. Practical classes in spoken Sanskrit. (7 hours)

Module II

Verbs- Singular, Dual and plural — First person, Second person, Third person.

Tenses – Past, Present and future – Atmanepadi and parasmaipadi-karthariprayoga.

(8hrs)

Module III

Words for communication and moral stories. (4 hrs)

Module IV

Chanakya Neethi first chapter (first 15 Shlokas) (6 hrs)

Module V

Translation of simple sentences from Sanskrit to English and vice versa.(5hs)

18SAN111 SANSKRIT II 1-0-2[2cr]

Module I

Seven cases, Avyayas, sentence making with Avyayas, Saptha kakaras.
(5hrs)

Module II

Kthavathu' Prathyayam, Upasargas, Kthvatha,Thumunnantha, Lyabantha Prathyayam. Three Lakaras – brief introduction, Lot lakara **(5hrs)**

Module III

New words and sentences for the communication, Slokas, moral stories(panchathanthra) Subhashithas, riddles (Selected from the Pravesha Book) **(5hrs)**

Module IV

Introduction to classical literature, classification of Kavyas, classification of Dramas - Important five Maha kavyas

(5hrs)

Module V

Translation of paragraphs from Sanskrit to English and wise -verse
(5hrs)

Module VI

Bhagavad - Geeta fourteenth chapter (all 27 Shlokas) **(5hrs)**

Essential Reading:

1, Praveshaha; Publisher : Samskrita bharati, Aksharam, 8th cross, 2nd phase, girinagar, Bangalore -560 085

2, Sanskrit Reader I, II and III, R.S. Vadhyar and Sons, Kalpathi, Palakkad

3, PrakriyaBhashyamwritten and published by Fr. John Kunnappally

4, Sanskrit Primer by Edward Delavan Perry, published by Ginn and Company Boston

5, Sabdamanjari, R.S. Vadyar and Sons, Kalpathi, Palakkad

6, Namalinganusasanam by Amarasimha published by Travancore Sanskrit series

7, SubhashitaRatnaBhandakara by Kashinath Sharma, published by Nirnayasagarpress