ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M. Sc. APPLIED MATHEMATICS (2 YEARS)

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

- The objective of the M.Sc programme in Applied Mathematics is to provide its students with a thorough knowledge of applicable mathematics and to develop their expertise in applying the methods and tools of mathematics to problems in science and engineering. Moreover, they should have sufficient insight in the underlying mathematical theory in order to be able to develop new mathematical methods and techniques if needed.

PROGRAMME OUTCOMES (POs):

- Students who qualify in M.Sc. Applied Mathematics are in fortunate position of having a wide range of career choices. The abilities to use logical thought, to make deduction from assumption, to use advanced concepts are all enhanced by a Mathematics degree course. With M.Sc. Applied Mathematics degree, one should be able to turn his/her hand to Finance, Statistics, Engineering, Computers, Teaching or Accountancy with a success not possible to other post graduates.

ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS

M. Sc. APPLIED MATHEMATICS (2 YEARS)

REGULATIONS – 2015
CHOICE BASED CREDIT SYSTEM
CURRICULA AND SYLLABI

SEMESTER - I

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MT7101	Abstract Algebra	PC	4	4	0	0	4
2.	MT7102	Advanced Calculus	PC	3	3	0	0	3
3.	MT7103	Object Oriented Programming	PC	3	3	0	0	3
4.	MT7104	Ordinary Differential Equations	PC	3	3	0	0	3
5.	MT7105	Real Analysis	PC	4	4	0	0	4
6.		Elective I	PE	3	3	0	0	3
PRACTICAL								
7.	MT7111	Object Oriented Programming Laboratory	PC	4	0	0	4	2
			TOTAL	**24**	**20**	**0**	**4**	**22**

SEMESTER - II

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MT7201	Classical Mechanics	PC	3	3	0	0	3
2.	MT7202	Complex Analysis	PC	4	4	0	0	4
3.	MT7203	Linear Algebra	PC	3	3	0	0	3
4.	MT7204	Partial Differential Equations	PC	4	4	0	0	4
5.	MT7205	Probability and Random Processes	PC	4	4	0	0	4
6.		Elective II	PE	3	3	0	0	3
			TOTAL	**21**	**21**	**0**	**0**	**21**

SEMESTER - III

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MT7301	Continuum Mechanics	PC	3	3	0	0	3
2.	MT7302	Functional Analysis	PC	3	3	0	0	3
3.	MT7303	Integral Transforms and Calculus of Variations	PC	4	4	0	0	4
4.	MT7304	Numerical Analysis	PC	3	3	0	0	3
5.	MT7305	Topology	PC	3	3	0	0	3
6.		Elective III	PE	3	3	0	0	3
PRACTICAL								
7.	MT7311	Computational Laboratory	PC	4	0	0	4	2
8.	MT7312	Project Work Phase -I	EEC	2	0	0	2	1
			TOTAL	**25**	**19**	**0**	**6**	**22**

SEMESTER – IV

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Elective IV	PE	3	3	0	0	3
2.		Elective V	PE	3	3	0	0	3
PRACTICAL								
3.	MT7411	Project Work Phase -II	EEC	20	0	0	20	10
			TOTAL	**26**	**6**	**0**	**20**	**16**

TOTAL NO. OF CREDITS: 81

PROFESSIONAL CORE (PC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Abstract Algebra	PC	4	4	0	0	4
2.		Advanced Calculus	PC	3	3	0	0	3
3.		Object Oriented Programming	PC	3	3	0	0	3
4.		Ordinary Differential Equations	PC	3	3	0	0	3

5.		Real Analysis	PC	4	4	0	0	4
6.		Object Oriented Programming Laboratory	PC	4	0	0	4	2
7.		Classical Mechanics	PC	3	3	0	0	3
8.		Complex Analysis	PC	4	4	0	0	4
9.		Linear Algebra	PC	3	3	0	0	3
10.		Partial Differential Equations	PC	4	4	0	0	4
11.		Probability and Random Processes	PC	4	4	0	0	4
12.		Continuum Mechanics	PC	3	3	0	0	3
13.		Functional Analysis	PC	3	3	0	0	3
14.		Integral Transforms and Calculus of Variations	PC	4	4	0	0	4
15.		Numerical Analysis	PC	3	3	0	0	3
16.		Topology	PC	3	3	0	0	3
17.		Computational Laboratory	PC	4	0	0	4	2

PROFESSIONAL ELECTIVES (PE)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MT7001	Advanced Analysis	PE	3	3	0	0	3
2.	MT7002	Advanced Graph Theory	PE	3	3	0	0	3
3.	MT7003	Algorithmic Graph Theory	PE	3	3	0	0	3
4.	MT7004	Analysis of Heat and Mass Transfer	PE	3	3	0	0	3
5.	MT7005	Approximation Theory	PE	3	3	0	0	3
6.	MT7006	Boundary Layer Theory	PE	3	3	0	0	3
7.	MT7007	Data Structures	PE	3	3	0	0	3
8.	MT7008	Design and Analysis of Algorithms	PE	3	3	0	0	3
9.	MT7009	Discrete Mathematics	PE	3	3	0	0	3
10.	MT7010	Finite Element Method	PE	3	3	0	0	3

11.	MT7011	Finite Volume Method	PE	3	3	0	0	3
12.	MT7012	Fixed Point Theory	PE	3	3	0	0	3
13.	MT7013	Fluid Mechanics	PE	3	3	0	0	3
14.	MT7014	Formal Languages and Automata Theory	PE	3	3	0	0	3
15.	MT7015	Functional Analysis and its Applications to PDE	PE	3	3	0	0	3
16.	MT7016	Fuzzy Set Theory	PE	3	3	0	0	3
17.	MT7017	Geometric Function Theory	PE	3	3	0	0	3
18.	MT7018	Graph Theory	PE	3	3	0	0	3
19.	MT7019	Mathematical Aspects of Finite Element Method	PE	3	3	0	0	3
20.	MT7020	Mathematical Finance	PE	3	3	0	0	3
21.	MT7021	Mathematical Programming	PE	3	3	0	0	3
22.	MT7022	Mathematical Statistics	PE	3	3	0	0	3
23.	MT7023	Networks, Games and Decisions	PE	3	3	0	0	3
24.	MT7024	Number Theory	PE	3	3	0	0	3
25.	MT7025	Number Theory and Cryptography	PE	3	3	0	0	3
26.	MT7026	Numerical Solutions of Partial Differential Equations	PE	3	3	0	0	3
27.	MT7027	Queueing and Reliability Modeling	PE	3	3	0	0	3
28.	MT7028	Stochastic Processes	PE	3	3	0	0	3
29.	MT7029	Theory of Elasticity	PE	3	3	0	0	3
30.	MT7030	Theory of Wavelets	PE	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Project Work - Phase I	EEC	2	0	0	2	1
2.		Project Work - Phase II	EEC	20	0	0	20	10

MT7101 **ABSTRACT ALGEBRA** **L T P C**
4 0 0 4

OBJECTIVE

- To introduce the concepts such as Group theory, Ring theory, Fields and Galois theory.

UNIT I INTRODUCTION TO GROUPS 12

Basic Axioms and Examples - Dihedral Groups - Symmetric Groups - Matrix Groups - The Quaternion Group - Homomorphisms and Isomorphisms - Group Actions - Subgroups - Cosets - Lagrange's theorem.

UNIT II MORE GROUP THEORY 12

Isomorphism theorems - Transpositions and the Alternating Group - Group Actions and Permutation Representations - Cayley's Theorem - The Class Equation - Automorphisms - Sylow's Theorem - Simplicity of A_n.

UNIT III POLYNOMIAL RINGS 12

Polynomial Rings over fields - Polynomial Rings that are Unique Factorization Domains - Irreducibiblity Criteria.

UNIT IV FIELDS 12

Extension Fields - Transcendence of e - Roots of Polynomials - Construction with Straight-Edge and Compass.

UNIT V GALOIS THEORY 12

More about Roots - The Elements of Galois Theory - Solvability by Radicals.

TOTAL: 60 PERIODS

OUTCOME

- The treatment on higher level of Algebra is reached out to students, after completion of the course.

TEXTBOOKS

1. Artin M., "Algebra", Prentice - Hall, New Jersey, 1991.
2. David S. Dummit and Richard M. Foote, "Abstract Algebra", John-Wiley & Sons, Third Edition, 2004.
3. Herstein I.N., "Topics in Algebra", Wiley, New York, Second Edition, 1975.

REFERENCES

1. Joseph A. Gallian, "Contemporary Abstract Algebra", Brooks/Cole, Seventh Edition, 2010.
2. Michael Artin, "Algebra", Prentice - Hall, New Jersey, 1991.
3. Fraleigh J. B., "A first course in Abstract Algebra", Narosa, 1990.
4. Lang S., "Algebra", Pearson Education, Third Edition, 1993.

MT7102 **ADVANCED CALCULUS** **L T P C**
3 0 0 3

OBJECTIVE:

- To introduce the basic notion of applied aspects of analysis and familiarize with the theoretical sides of the subject.

UNIT I PARTIAL DIFFERENTIATION 9

Functions of several variables - Homogeneous functions - Total derivative - Higher order Derivatives, Equality of cross derivatives - Differentials - Directional Derivatives.

UNIT II IMPLICIT FUNCTIONS AND INVERSE FUNCTIONS 9

Implicit functions - Higher order derivatives - Jacobians - Dependent and independent variables - The inverse of a transformation - Inverse function theorem - Change of variables - Implicit function theorem - Functional dependence - Simultaneous equations.

UNIT III TAYLOR'S THEOREM AND APPLICATIONS 9

Taylor's theorem for functions of two variables - Maxima and Minima of functions of two and three variables - Lagrange Multipliers.

UNIT IV LINE AND SURFACE INTEGRALS 9

Definition of line integrals - Green's theorem - Applications - Surface integrals - Gauss theorem - Verification of Green's and Gauss theorems.

UNIT V TRANSFORMATION AND LINE INTEGRALS IN SPACE 9

Change of variables in multiple integrals - Definition of line integrals in space - Stoke's theorem - Verification of Stoke's theorem.

TOTAL: 45 PERIODS

OUTCOME

- This course prepares the student to take up other courses in Mathematics. It provides theoretical foundation for calculus of one and several variables at advanced level.

TEXTBOOKS

1. Widder D.V.,"Advanced Calculus", Prentice Hall of India, New Delhi, 12th Print, Second Edition, 2002.
2. Kaplan W., "Advanced Calculus", Addison Wesley (Pearson Education, Inc.), Fifth Edition, 2003.

REFERENCES

1. Malik S.C., "Mathematical Analysis", New Age International Publishers, New Delhi, 1992.
2. Burkill J.C. and Burkill H., "A Second course in Mathematical Analysis", Cambridge University Press, New York, 2002.
3. Apostol T.M., "Mathematical Analysis", Second Edition, Narosa Publishing House, New Delhi, 2013.

MT7103	OBJECT ORIENTED PROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVES

- The language accommodates several programming paradigms, including object-oriented programming, generic programming, and the traditional procedural programming. It exposes students to modern object-oriented programming techniques that have proved successful in the development of large complex software systems by multiple programmers. It teaches object-oriented design and explores techniques for building modular, efficient and robust systems. The goal of the course is to develop skills such as program design and testing as well as the implementation of programs using object-oriented features.

UNIT I FUNDAMENTALS OF OOP 9

Object Oriented Paradigm – Procedural oriented programming Vs. Object Oriented Programming - Characteristics of Object Oriented Programming – Introduction to C++ - Data Types - Control Structures - Expressions

UNIT II OOP PROGRAMMING IN C++ 9

Classes and objects – creating and accessing class members – Constructor and Destructor – Objects- Member Functions - Inline Function - Friend Functions - Operator Overloading – prefix and postfix, overloading binary operators, instream/outstream operator overloading - Function Templates and Class Templates

UNIT III INHERITANCE 9

Introduction - protected data, private data, public data - inheriting constructors and destructors, constructors for virtual base classes, constructors and destructors of derived classes and virtual functions, size of derived class - order of invocation - types of inheritance - single inheritance, hierarchical inheritance, multiple inheritance, hybrid inheritance.

UNIT IV POLYMORPHISM AND VIRTUAL FUNCTIONS 9

Importance of virtual function, function call binding, virtual functions, implementing late binding, need for virtual functions, abstract base classes and pure virtual functions, virtual destructors.

UNIT V FILES AND STREAMS 9

Components of a file, file operations, communication in files, creation of file streams, stream classes, header classes, header files, updating of files, opening and closing a file, file pointers and their manipulations, function manipulation of file pointers, detecting end-of-file.

TOTAL: 45 PERIODS

OUTCOMES

- Students will be able to design and write computer programs that are correct, simple, clear, efficient, well organized, and well documented.
- Students will be able to apply programming skills in the areas of pure, applied mathematics and related areas.
- The student will understand the hardware and software aspects of computer systems that support application software development.

TEXTBOOKS:

1. H. M. Deitel and P. J. Deitel, "C++ How to Program", Prentice Hall of India Pvt. Ltd., New Delhi, Seventh Edition, 2010.
2. Bjarne Stroustrup, "The C++ Programming Language", Pearson Education, 2005..

REFERENCES:

1. Robert Lafore, "Object Oriented Programming in Microsoft C++", Pearson Education, Fourth Edition, 2010.
2. Horstmann, "Computing Concepts with C++ Essentials", John Wiley, Third Edition, 2003.
3. Balaguruswamy E., "Programming with JAVA", Tata McGraw Hill, Third Edition, 2007.
4. Deitel and Deitel, "Java – How to Program", Prentice Hall of India Pvt. Ltd., New Delhi, 2009.
5. Balaguruswamy E., "Object Oriented Programming Using C++ and JAVA", Tata McGraw Hill, New Delhi, May, 2012
6. Balaguruswamy E., "Object Oriented Programming with C++", Tata McGraw Hill, New Delhi, Fourth Edition, 2007.

MT7104 **ORDINARY DIFFERENTIAL EQUATIONS** **L T P C**
3 0 0 3

OBJECTIVE

- Aims at a thorough introduction to ordinary differential equations from both theoretical and applied point of view.

UNIT I LINEAR EQUATIONS 9

Higher order equations - Linear independence - Wronskian - Variation of parameters - Systems of Linear differential equations - Existence and uniqueness theorem.

UNIT II EXISTENCE THEOREM AND BOUNDARY VALUE PROBLEMS 9

Successive approximations - Picard's theorem - Boundary Value problems - Sturm - Liouville problem - Green's Functions.

UNIT III STABILITY 9

Autonomous systems - The phase plane - Critical points and stability for linear systems - Stability by Liapunov's direct method - Simple critical points of non-linear systems.

UNIT IV LEGENDRE EQUATION 9

Power series solutions - Second order linear equations with ordinary points - Legendre equation - Legendre polynomials - Rodrigue's formula - Recurrence relations - Orthogonality.

UNIT V BESSEL EQUATION 9

Second order equations with regular singular points - Series solution - Bessel Equation - Bessel functions of first kind - Recurrence relations - Orthogonality.

TOTAL: 45 PERIODS

OUTCOME

- The students will be able to formulate and solve some practical problems as ordinary differential equations.

TEXTBOOKS

1. Deo S.G., Lakshmikantham V. and Raghavendra V. "Text Book of Ordinary Differential Equations", Tata McGraw-Hill Publishing Company Ltd., Second Edition, 2000.
2. Simmons G.F. and Krantz S. G., "Differential Equations, Theory, Technique and Practice", Tata McGraw-Hill Publishing Company Ltd., Second Edition, 2006.

REFERENCES

1. Ravi P. Agarwal and Ramesh C. Gupta, "Essentials of Ordinary Differential Equations", Tata McGraw-Hill Book Company, 1993.
2. Elsgolts L., "Differential equation and the calculus of variations", MIR Publications,1980.
3. Birkhoff, G. and Rota, G. C., "Ordinary Differential Equations", John Wiley & Sons, 4th Edition, 1989

MT7105 **REAL ANALYSIS** **L T P C**
4 0 0 4

OBJECTIVES

- Real Analysis is the fundamental behind almost all other branches of Mathematics.
- The aim of the course is to make the students understand the basic concepts of Real analysis.

UNIT I CONTINUITY AND RIEMANN-STIELTJES INTEGRAL 12

Limit – Continuity - Connectedness and Compactness - Definition and existence of the integral - Properties of the integral - Integration and Differentiation.

UNIT II SEQUENCES AND SERIES OF FUNCTIONS 12

Pointwise convergence - Uniform convergence - Uniform convergence and continuity - Uniform convergence and Integration, Uniform Convergence and differentiation. Equi - continuous families of functions, Weierstrass and Stone-Weierstrass theorem.

UNIT III MEASURE AND MEASURABLE SETS 12

Lebesgue Outer Measure - Measurable Sets - Regularity - Measurable Functions - Abstract Measure - Outer Measure - Extension of a Measure - Measure Spaces.

UNIT IV LEBESGUE INTEGRAL 12

Integrals of simple functions - Integrals of Non Negative Functions - Fatou's Lemma, Lebesgue monotone convergence Theorem - The General Integral - Riemann and Lebesgue Integrals - Integration with respect to a general measure - Lebesgue Dominated Convergence Theorem.

UNIT V LEBESGUE DECOMPOSITION 12

Signed measures and Hahn Decomposition - Radon-Nikodym Theorem and Lebesgue Decomposition Theorem - Riez Representation Theorem for L^1 and L^p .

TOTAL : 60 PERIODS

OUTCOMES

- The students will be able to understand the treatment of Integration in the sense of both Riemann and Lebesgue.
- The students get introduce to the approach of integration via measure, rather than measure via integration.
- The students will be able to understand the methods of Decomposing signed measures which has applications in probability theory and Functional Analysis.

TEXTBOOKS

1. Rudin, W., "Principles of Mathematical Analysis", Mc Graw-Hill, Third Edition, 1984.
2. G. de Barra, "Measure Theory and Integration", New Age International Pvt. Ltd, Second Edition, 2013.

REFERENCES

1. Avner Friedman, "Foundations of Modern Analysis", Hold Rinehart Winston, 1970.
2. Rana I. K., "An Introduction to Measure and Integration", Narosa Publishing House Pvt. Ltd., Second Edition, 2007.
3. Royden H. L., "Real Analysis", Prentice Hall of India Pvt. Ltd., Third Edition, 1995.

MT7111 OBJECT ORIENTED PROGRAMMING LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVE:

- The purpose of this lab course is to develop skills in program designing and testing using C++.

1. Console I/O operations
2. Function Overloading
3. Function Templates and Class Templates in C++

4. Classes in C++ with all possible operations/operators for encapsulating Complex Number,
   String, Time, Date and Matrix (Operators are to be overloaded)
5. Scope Resolution and Memory Management Operators
6. Inheritance
7. Virtual Functions
8. Friend Functions
9. Constructors and Destructors
10. 'this' Pointer
11. File I/O Operations

TOTAL: 60 PERIODS

OUTCOMES

- Students will be able to understand the difference between procedural and object-oriented programming approach.
- Students will be able to implement the mathematical knowledge of analysis.
- Students will be able to program Discrete mathematical structures and related algorithms using object-oriented programming concepts.

REFERENCES

1. Balaguruswamy E., "Object Oriented Programming Using C++ and JAVA", Tata McGraw Hill, New Delhi, May, 2012.
2. Deitel and Deitel, "Java – How to Program", Prentice Hall of India Pvt. Ltd., New Delhi, 2009.
3. Robert Lafore, "Object Oriented Programming in Microsoft C++", Pearson Education, Fourth Edition, 2010.
4. H. M. Deitel and P. J. Deitel, "C++ How to Program", Prentice Hall of India Pvt. Ltd., New Delhi, Seventh Edition, 2010.

MT7201	CLASSICAL MECHANICS	L T P C
		3 0 0 3

OBJECTIVE

- Classical Mechanics is one of the two major sub fields of mechanics. It emphasis the motion of macroscopic objects from projectiles to the pass of machinery as well as astronomical objects on the qualitative structure of phase space.

UNIT I KINEMATICS 9

Kinematics of a particle and a rigid body - Moments and products of inertia - Kinetic energy - Angular momentum.

UNIT II METHODS OF DYNAMICS IN SPACE 9

Motion of a particle - Motion of a system - Motion of a rigid body.

UNIT III APPLICATIONS OF DYNAMICS IN SPACE 9

Motion of a rigid body with a fixed point under no forces - Spinning top - General motion of top.

UNIT IV EQUATIONS OF LAGRANGE AND HAMILTON 9

Lagrange's equation for a particle - Simple dynamical system - Hamilton's equations.

UNIT V HAMILTONIAN METHODS 9

Natural Motions - Space of events - Action - Hamilton's principle - Phase space - Liouville's theorem.

TOTAL: 45 PERIODS

OUTCOME

- This subject emphasis the analysis of problems in which quantum and relativistic effects are negligible and its principle and mathematics are the foundation upon which numerous branches of modern physics are founded.

TEXTBOOK

1. Synge L. and Griffith B.A., "Principles of Mechanics", Tata McGraw Hill, 1984.

REFERENCES

1. Rana N.C. and Joag P.S., "Classical Mechanics", Tata McGraw Hill, 1991.
2. Berger V.D. and Olsson M.G., "Classical Mechanics - a modern perspective", Tata McGraw Hill International,1995.
3. Bhatia V.B., "Classical Mechanics with introduction to non-linear oscillations and chaos", Narosa Publishing House, 1997.
4. Sankara Rao K. "Classical Mechanics", Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
5. Greenwood D. T., "Principles of Dynamics", Prentice Hall of India Pvt. Ltd., New Delhi, 1988.
6. David Morin, "Introduction to Classical Mechanics with problems and solutions", Cambridge University Press, New Delhi, 2007.

MT7202	COMPLEX ANALYSIS	L T P C
		4 0 0 4

OBJECTIVE

- To introduce the concept of Analytic function the basic analogous of complex line integral, Cauchy theorem, the fundamental of entire and mermorphic function. The emphasis is on Riemann mapping theorem and hadamard theorem.

UNIT I COMPLEX INTEGRATION 12

Analytic functions - Cauchy's theorem for rectangle - Cauchy's theorem for disk - Integral formula - Local properties of analytic functions - Schwartz lemma - Maximum Modulus principle.

UNIT II CALCULUS OF RESIDUES 12

Homology - Homologous form of Cauchy's theorem - Calculus of Residues - Contour integration through residues.

UNIT III DOMAIN CHANGING MAPPINGS 12

Conformality - Normal family - Riemann mapping theorem.

UNIT IV HARMONIC FUNCTIONS 12

Properties - The mean-value property - Poisson's Formula - Schwarz's theorem - Harnack's principle.

UNIT V MEROMORPHIC AND ENTIRE FUNCTIONS 12

Meromorphic functions - Mittag Leffler's theorem - Partial fraction - Infinite product - Canonical Product - Gamma Functions - Jensen's formula - Order and Genus of an Entire function - Hadamard's theorem - Riemann Zeta function.

TOTAL: 60 PERIODS

OUTCOME

- The student will get good foundation on complex analysis as well as motivation at advanced level.

TEXTBOOK

1. Lars V. Ahlfors, ”Complex Analysis”, McGraw Hill International , Third Edition ,1979.

REFERENCES

1. Conway J.B., “Functions of one Complex variables”, Springer International Student Edition, Second Edition, 2000.
2. Mathews J.H. and Howell R.W., “Complex Analysis for Mathematics and Engineering”, Narosa Publishing House, Third Edition, 1998.
3. E.B. Staff, A.D.Snider, “Fundamentals of Complex Analysis with applications to Engineering and Science”, Pearson Education, Third Edition, 2008.

MT7203	**LINEAR ALGEBRA**	**L T P C**
		3 0 0 3

OBJECTIVE

- To get a strong background for varied courses, to make the students understand the basic concepts, approaches and methods for the study of linear transformations, their algebra and their representation by matrices.

UNIT I VECTOR SPACES AND LINEAR TRANSFORMATIONS 12

Vector Spaces – Subspaces – Bases and Dimension– Computations Concerning Subspaces - Linear transformations – The Algebra of Linear transformations – isomorphism – Representation of transformations by matrices.

UNIT II LINEAR FUNTIONALS AND ANNIHILATING POLYNOMIALS 8

Linear Functionals – The Double Dual – Transpose of Linear Transformation – Characteristic Values – Annihilating Polynomials.

UNIT III DIRECT SUM AND THE PRIMARY DECOMPOSITION THEOREM 8

Invariant Subspaces – Direct-Sum Decomposition – Invariant Direct Sums – The Primary Decomposition Theorem.

UNIT IV CANONICAL FORMS 8

Triangular Form – Nilpotent Transformations – Jordan form – Rational Canonical Form.

UNIT V TRANSFORMATIONS AND QUADRATIC FORMS 9

Trace and Transpose – Determinants – Hermitian, Unitary, and Normal Transformations - Real Quadratic Forms.

TOTAL : 45 PERIODS

OUTCOME

- The students would have developed their knowledge and understanding of the concepts of Linear Algebra such as basic concepts to the analysis of a linear transformation on a finite dimensional vector spaces, the analysis of characteristic values, canonical forms and quadratic forms.

TEXTBOOKS

1. Hoffmann K. and Kunze R., "Linear Algebra", Prentice Hall of India, Second Edition, 2000.
2. Herstein I.N.," Topics in Algebra" Wiley eastern Limited, Second Edition, 2006.

REFERENCES

1. Gilbert Strang, "Linear Algebra and its applications", Thomson, Third Edition, 1998.
2. S. Kumaresan, "Linear Algebra: A Geometric Approach", Prentice Hall of India, 2006.
3. Seymour Lipschutz, "Schaum's Outlines of Linear Algebra", Tata McGraw Hill, Third Edition, 2005.

MT7204 PARTIAL DIFFERENTIAL EQUATIONS **L T P C**
4 0 0 4

OBJECTIVE

- To teach the concepts and techniques for solving partial differential equations.

UNIT I FIRST ORDER EQUATIONS 12

Formation of Partial Differential Equations – Lagrange's equation - Integral surfaces passing through a given curve - Surfaces orthogonal to a given system of surfaces - Compatible system of equations - Charpit's method.

UNIT II SECOND ORDER EQUATIONS 12

Classification of second order Partial Differential Equations - Reduction to canonical form - Adjoint operators.

UNIT III HYPERBOLIC EQUATIONS 12

One-dimensional wave equation - Initial value problem - D'Alembert's solution - Riemann - Volterra solution - Vibrating string - Variables Separable solution - Forced vibrations - Solutions of Non-homogeneous equation - Vibration of a circular membrane.

UNIT IV PARABOLIC EQUATIONS 12

Diffusion equation - Method of Separation of variables: Solution of one and two dimensional Diffusion equations in cartesian coordinates and Solution of Diffusion equation in cylindrical and spherical polar coordinates.

UNIT V ELLIPTIC EQUATIONS 12

Boundary value problems - Properties of harmonic functions - Green's Function for Laplace Equation - The Methods of Images - The Eigenfunction of Method.

TOTAL: 60 PERIODS

OUTCOME

- The students will be in a position to solve partial differential equations arising in various branches of Science and Engineering.

TEXTBOOKS

1. Sneddon I.N., "Elements of Partial Differential Equations", Tata Mc-Graw Hill Book Company, 1985.
2. Sankara Rao K., "Introduction to Partial Differential Equations", Prentice Hall of India, 2007.

REFERENCES

1. Dennemeyer R., "Introduction to Partial Differential Equations and Boundary Value Problems", Tata McGraw Hill Book Company, 1968.
2. Pinsky M.A., "Partial Differential Equations and Boundary Value Problems", Tata McGraw Book Company, Third Edition, 1998.
3. Coleman P. M., "An Introduction to Partial Differential Equations with MAT LAB", Chapman & Hall / CRC, 2005.

MT7205 PROBABILITY AND RANDOM PROCESSES

L	T	P	C
4	0	0	4

OBJECTIVE

- To introduce the standard probability distributions and the analysis of random phenomena observed in engineering and physical sciences.

UNIT I PROBABILITY AND RANDOM VARIABLES 12

Probability Concepts - Random variables - Bernoulli, Binomial, Geometric, Poisson, Uniform, Exponential, Erlang, Weibull and Normal distributions - Functions of a Random variable - Moments, Moment generating function.

UNIT II TWO DIMENSIONAL RANDOM VARIABLES 12

Joint distributions - Transformation of random variables and their distributions - Conditional expectation - Computing probabilities and expectations by conditioning - Correlation and Regression.

UNIT III LIMIT THEOREMS 12

Modes of convergence - Markov, Chebyshev's and Jensen's inequalities - Weak law of large numbers - Strong law of large numbers - Central limit theorem (i.i.d case).

UNIT IV MARKOV CHAINS 12

Stochastic processes - Classification - Markov chain - Chapman Kolmogorov equations - Transition probability Matrix - Classification of states - First passage times – Stationary distribution - Mean time spent in a transient state.

UNIT V MARKOV PROCESSES 12

Markov process - Poisson process - Pure birth process - Pure death process - Birth and death process - Limiting probabilities - Non-homogeneous Poisson process - Compound Poisson process.

TOTAL: 60 PERIODS

OUTCOME

- The students will be able to work creatively on scientific and engineering-based real world problems involving stochastic modelling.

TEXTBOOKS

1. Ross S.M., "Introduction to Probability Models", Academic Press Inc., Ninth Edition, 2007.
2. Rohatgi V.K. and A.K. Md. Ehsanes Saleh," An introduction to Probability and Statistics", John Wiley & Sons, Inc., Second Edition, 2001.

REFERENCES
1. Karlin S and H.M.Taylor, "A First Course in Stochastic Processes", Academic Press, Second Edition,1975, (An imprint of Elsevier).
2. Medhi J, "Stochastic Processes", New Age International (P) Ltd., New Delhi, Second Edition, 2001.

MT7301 **CONTINUUM MECHANICS** **L T P C**
3 0 0 3

OBJECTIVE
- Continuum Mechanics is a branch of mechanics that deals with the analysis of the kinematics and the mechanical behaviour of materials modeled as a continuous mass rather than a discrete particle.

UNIT I TENSORS 9
Summation Convention - Components of a tensor - Transpose of a tensor - Symmetric & anti-symmetric tensor - Principal values and directions - Scalar invariants.

UNIT II KINEMATICS OF A CONTINUUM 9
Material and Spatial descriptions - Material derivative - Deformation - Principal Strain - Rate of deformation - Conservation of mass - Compatibility conditions.

UNIT III STRESS 9
Stress vector and tensor - Components of a stress tensor - Symmetry - Principal Stresses - Equations of motion - Boundary conditions.

UNIT IV LINEAR ELASTIC SOLID 9
Isotropic solid - Equations of infinitesimal theory - Examples of elastodynamics and elastostatics.

UNIT V NEWTONIAN VISCOUS FLUID 9
Equations of hydrostatics - Newtonian fluid - Boundary conditions - Stream lines – Examples of laminar flows - Vorticity vector - Irrotational flow.

TOTAL : 45 PERIODS

OUTCOME
- This course emphasises that the student should be familier with vector analysis, including the laws of Gauss and Stokes and should have some understanding of matrix operations. The key mathematical concept in continuum mechanics is the tensor and it convects the mathematical notion of a tensor to the physics of continuous media.

TEXTBOOK
1. Lai W.M., Rubin D. and Krempel E., "Introduction to Continuum Mechanics", Pergamon Unified Engineering Series, 1974.

REFERENCES
1. Hunter S.C., "Mechanics of Continuous Media", Ellis Harwood Series, 1983.
2. Chandrasekaraiah D.S. and Loknath Debnath, "Continuum Mechanics", Prism Books Private Limited, 1994.
3. Chung T.J., "Continuum Mechanics", Prentice Hall, 1988.

MT7302 **FUNCTIONAL ANALYSIS** **L T P C**
3 0 0 3

OBJECTIVES

- To teach the fundamentals of Functional Analysis.
- The topic include Hahn-Banach theorem, Open mapping theorem, Closed graph theorem, Riesz-Representation theorem, etc.

UNIT I BANACH SPACES 7

Banach Spaces - Definition and Examples - Continuous linear transformations.

UNIT II FUNDAMENTAL THEOREMS IN NORMED LINEAR SPACES 9

The Hahn-Banach theorem - The natural imbedding of N in N** - The open mapping theorem - Closed graph theorem - The conjugate of an operator - Uniform boundedness theorem.

UNIT III HILBERT SPACES 10

Hilbert Spaces - Definition and Properties - Schwarz inequality - Orthogonal complements - Orthonormal sets - Bessel's inequality - Gram–Schmidt orthogonalization process - The conjugate space H*- Riesz-Representation theorem.

UNIT IV OPERATOR ON A HILBERT SPACE 9

The adjoint of an operator - Self-adjoint operators - Normal and unitary operators - Projections.

UNIT V SPECTRAL AND FIXED POINT THEOREMS 10

Matrices - Determinants and the spectrum of an operator - Spectral theorem - Fixed point theorems and some applications to analysis.

TOTAL: 45 PERIODS

OUTCOMES

- The student will be in a position to take up advance courses in analysis.
- The student will be able to apply the concepts and theorems for studying numerical analysis, design maturity, the evolution of the design and the complexity of the mission, etc.

TEXTBOOKS

1. Simmons G.F., "Introduction to Topology and Modern Analysis", Tata Mc-Graw Hill Pvt. Ltd., New Delhi, 2011.
2. Kreyszig E.," Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 2007.

REFERENCES

1. Limaye B. V.," Functional Analysis", New Age International Ltd., Publishers, Second Edition, New Delhi,1996.
2. Coffman C. and Pedrick G., "First Course in Functional Analysis", Prentice-Hall of India, New Delhi, 1995.
3. Conway J.B., "A Course in Functional Analysis", Springer-Verlag, New York, 2008.
4. Bollobas B., "Linear Analysis", Cambridge University Press, Indian Edition, New York, 1999.
5. Nair M.T., "Functional Analysis, A First course", Prentice Hall of India, New Delhi, 2010.

MT7303 INTEGRAL TRANSFORMS AND CALCULUS OF VARIATIONS **L T P C**
4 0 0 4

OBJECTIVES

- To familiarize the students in the field of differential and elliptic equations to solve boundary value problems associated with engineering applications.
- To expose the students to variational formulation and numerical integration techniques and their applications to obtain solutions for one and two dimensional conditions.

UNIT I LAPLACE TRANSFORMS 12

Transforms of elementary functions - Unit step and Dirac delta functions - Properties - Differentiation and integration of transforms - Periodic functions - Initial & final value theorems - Inverse Laplace transforms - Convolution theorem - Error function - Transforms involving Bessel functions.

UNIT II FOURIER TRANSFORMS 12

Fourier integral representation - Fourier transform pairs - Properties - Fourier sine and cosine transforms - Transforms and inverse transforms of elementary functions - Convolution theorem - Transforms of derivatives.

UNIT III APPLICATIONS OF TRANSFORMS 12

Application of Laplace Transforms - Evaluation of integrals - Solution of Linear ODE - Applications of Fourier Transforms – wave equation -Heat equation on infinite and semi-infinite line - Potential problems in half-plane.

UNIT IV VARIATIONAL PROBLEMS 12

Variation of a functional and its properties - Euler's equations - Functionals with several arguments - Higher order derivatives - Functionals dependent on functions of several independent variables - Variational Problems in Parametric form.

UNIT V MOVING BOUNDARIES AND DIRECT METHODS IN VARIATIONAL PROBLEMS 12

Variation problems with a movable boundary for functionals dependent on one and two functions - One-sided variations - Constraints - Isoperimetric Problems - Direct Methods in Variational Problems - Rayleigh-Ritz method and Kantorovich method

TOTAL: 60 PERIODS

OUTCOME

- This subject is to develop the mathematical methods of applied mathematics and mathematical physics with an emphasis on calculus of variation and integral transforms.

TEXTBOOKS

1. Andrews, L.C. and Shivamoggi, B.K., "Integral Transforms for Engineers", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
2. Gupta, A.S., "Calculus of Variations with Applications", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.

REFERENCES

1. Sneddon, I.N., "The use of integral Transforms", Tata Mc-Graw Hill, 1974.
2. Elsgolts,L., "Differential equations and the Calculus of Variations", MIR Publishers, 1980.
3. Churchill, R.V, " Operational Mathematics", Mc Graw Hill Company, 3rd Edition,1972, U.S.A.

MT7304 **NUMERICAL ANALYSIS** **L T P C**
3 0 0 3

OBJECTIVE

- The aim of the course is to make the students understand the mathematical concepts of numerical methods, their implementation and analysis.

UNIT I SYSTEMS OF LINEAR EQUATIONS AND ALGEBRAIC EIGENVALUE PROBLEMS 9

Direct Method: Gauss elimination method - Error Analysis - Iterative methods: Gauss-Jacobi and Gauss-Seidel - Convergence considerations - Eigenvalue Problem: Power method.

UNIT II INTERPOLATION, DIFFERENTIATION AND INTEGRATION 9

Interpolation: Lagrange's and Newton's interpolation - Errors in interpolation - Optimal points for interpolation - Numerical differentiation by finite differences - Numerical Integration: Trapezoidal, Simpson's and Gaussian quadratures - Error in quadratures.

UNIT III APPROXIMATION OF FUNCTIONS 9

Norms of functions - Best Approximations: Least squares polynomial approximation - Approximation with Chebyshev polynomials - Piecewise Linear & Cubic Spline approximation.

UNIT IV ORDINARY DIFFERENTIAL EQUATIONS 9

Single-Step methods: Euler's method - Taylor series method - Runge-Kutta method of fourth order - Multistep methods: Adams-Bashforth and Milne's methods – Stability considerations - Linear Two point BVPs: Finite Difference method.

UNIT V PARTIAL DIFFERENTIAL EQUATIONS 9

Elliptic equations: Five point finite difference formula in rectangular region - Truncation error; One-dimensional Parabolic equation: Explicit and Crank-Nicholson schemes; Stability of the above schemes - One-dimensional Hyperbolic equation: Explicit scheme;

TOTAL : 45 PERIODS

OUTCOMES

- The students will be able to undertake the study of advanced courses like Numerical solution of Partial Differential Equations, Functional Analysis and its applications to Partial Differential Equations.
- The students will be able to understand, analyze and solve various problems arising in Science and Engineering numerically.

TEXTBOOKS

1. Atkinson K.E., "An Introduction to Numerical Analysis", Wiley, 1989.
2. Conte S.D. and Carl de Boor, "Elementary Numerical Analysis", Tata McGraw-Hill Publishing Company, Third Edition, 2005.
3. Kincaid D. and Chenney W., "Numerical Analysis: Mathematics of Scientific Computing", AMS, University Press, Hyderabad, Third Edition, 2009.

REFERENCES

1. Isaacson E. and Keller, H.B., "Analysis of Numerical Methods" , Dover Publication, 1994.
2. Philips G.M and Taylor P.J., "Theory and Applications of Numerical Analysis", Elsevier, New Delhi, Second Edition, 2006.
3. Jain M.K., Iyengar S.R.K. and Jain R.K., "Numerical Methods for Scientific and Engineering", New Age International Pub. Co., Third Edition, 1993.
4. Iserles, A., "A first course in the Numerical Analysis of Differential Equations", Cambridge University press, New Delhi, 2010.
5. Brian Bradie., "A Friendly Introduction to Numerical Analysis", Pearson Education, New Delhi, First Edition, 2007

6. C. E. Froberg., "Introduction to Numerical Analysis", Addison-Wesley Publishing Company, Second Edition, 1969.

MT7305 TOPOLOGY L T P C
3 0 0 3

OBJECTIVE

- To introduce the basic notion of a topological space, continuous mappings between topological spaces connectedness and compactness of a topological space. Also to teach them the countability and separation axioms, Urysohn metrization theorem and Tychonoff theorem.

UNIT I TOPOLOGICAL SPACES 9

Topological spaces - Basis for a topology - Product topology on finite cartesian products - Subspace topology.

UNIT II CLOSED SETS AND CONTINUOUS FUNCTIONS 9

Closed sets and Limit points - Continuous functions - Homeomorphism - Metric Topology - Uniform limit theorem.

UNIT III CONNECTEDNESS AND COMPACTNESS 9

Connected spaces - Components - Path components - Compact spaces - Limit point compactness - Local compactness.

UNIT IV COUNTABILITY AND SEPARATION AXIOMS 9

Countability axioms - T_1-spaces - Hausdorff spaces - Completely regular spaces - Normal spaces.

UNIT V URYSOHN LEMMA AND TYCHONOFF THEOREM 9

Urysohn lemma - Urysohn metrization theorem - Imbedding theorem - Tietze extension theorem - Tychonoff theorem.

TOTAL : 45 PERIODS

OUTCOME

- The students will get good foundation for future study in analysis and in geometry.

TEXTBOOK

1. Munkres J.R., “Topology”, Prentice-Hall of India, New Delhi, Second Edition, 2003.

REFERENCES

1. Simmons G.F., “Introduction to Topology and Modern Analysis”, International Student Edition, Tata McGraw Hill Kogakusha Ltd., 1983.
2. Murdeshwar M.G., “General Topology”, Wiley Eastern, Second Edition, 1990.
3. Kelly J.L., “General Topology”, Van Nostrand, 1955.
4. Dugundji J., “Topology”, University Book Stall, New Delhi, 1990.
5. Joshi K. D., “Introduction to General Topology”, New Age International, New Delhi, 2000.

MT7311 **COMPUTATIONAL LABORATORY** **L T P C**
0 0 4 2

OBJECTIVE

- To have exposure and usage to software packages such as MATLAB, SPSS and TORA for mathematical computations in Numerical methods, Statistics and Operations research respectively.

OUTCOME

- Students will be capable of handling any mathematical techniques using MATLAB, SPSS and TORA.

C or C++ PROGRAMS

1. Program on Matrix manipulation
2. Program to solve a system of linear equations using Gauss Elimination method
3. Program to solve a system of linear equations using Seidel method
4. Program to solve a system of linear equations using Gauss Jordan method
5. For a given matrix, find the eigenvalue and eigenvector using Power Method

MATLAB PROGRAMS

6. Newton's Forward and Backward Method
7. Newton's Divided Difference
8. Simpson 1/3 and 3/8 Method
9. Program on ordinary differential equation
10. Program on Quadratic Equations
11. Splines
12. 2D Graphs
13. 3D Graphs
14. Program on Statistical Data Analysis
15. Program to Animation

TORA

16. Program on Simplex method
17. Program on transportation model
18. Program on linear programming
19. Program on Big M method
20. Program on Integer Programming
21. Program on Graph Theory (Traversal)

SPSS

22. Statistical Data Analysis using SPSS(t-test, F-test, Chi-square test and ANOVA)

TOTAL : 60 PERIODS

REFERENCES:

1. Duane C. Hanselman, Bruce L. Littlefield, "Mastering MATLAB 7", Pearson Education, 2011.
2. Rudra Pratap, "Getting Started with MATLAB", Oxford University Press, 2010.
3. Raj Kumar Bansal, Ashok Goel, Manoj Kumar Sharma, "MATLAB and Its Applications in Engineering", Pearson Education, 2012.
4. Taha, H.A. "Operations Research: An Introduction", Pearson Education, India, Ninth Edition, 2012.

Elective Courses / Soft Core Courses

MT7001 **ADVANCED ANALYSIS** **L T P C**
3 0 0 3

OBJECTIVES

- Real Analysis is the fundamental behind almost all other branches of Mathematics.
- The aim of the course is to make the students understand the basic and advanced concepts of Real analysis.

UNIT I L_p SPACES 9

Convex functions and inequalities - The L_p spaces - Approximation by continuous functions - Trigonometric series completeness of trigonometric system.

UNIT II COMPLEX MEASURES 9

Total variation - Absolute continuity, Consequences of the Radon-Nikodym theorem - Bounded linear functionals on L_p - The Riesz representation theorem.

UNIT III FOURIER TRANSFORMS 9

Formal properties - The inversion theorem - The Plancherel theorem - The Banach algebra L_1.

UNIT IV DIFFERENTIATION AND PRODUCT SPACES 9

Derivatives of measures - The fundamental theorem of calculus - Differentiable transformations - Measurability on Cartesian Products-Product measures-Fubini's Theorem - Convolutions.

UNIT V HOLOMORPHIC FOURIER TRANSFORMS 9

Introduction - Two theorems of Paley and Wiener - Quasi-analytic classes - The Denjoy Carleman theorem.

TOTAL : 45 PERIODS

OUTCOMES

- The students get introduced to the classical Banach spaces.
- The students will get good understanding of methods of decomposing signed measures which has applications in probability theory and Functional Analysis.
- The students will get good understanding of Fourier Transform and its Holomorphic extensions.

TEXTBOOK

1. Walter Rudin, "Real and Complex Analysis", Tata McGraw-Hill, Third Edition,1989.

REFERENCES

1. De Barra G., "Measure Theory and Integration", New Age International Pvt. Ltd, Second Edition, 2013.
2. Avner Friedman, "Foundations of Modern Analysis", Hold Rinehart Winston, 1970.
3. Rana I. K., "An Introduction to Measure and Integration", Narosa Publishing House Pvt. Ltd., Second Edition, 2007.

MT7002 **ADVANCED GRAPH THEORY** **L T P C**
3 0 0 3

OBJECTIVE

- To introduce the students some of the potential and advanced topics on Algebraic Graph theory, Extremal Graph theory and Directed graphs.

UNIT I RAMSEY THEORY 9

Ramsey's Theorem - Ramsey Numbers - Graph Ramsey Theory - Sperner's Lemma and Bandwidth.

UNIT II EXTREMAL GRAPHS 9

Encodings of Graphs - Branchings and Gossip - List Coloring and Choosability - Partitions Using Paths and Cycles.

UNIT III EIGENVALUES OF GRAPHS 9

The Characteristic Polynomial - Linear Algebra of Real Symmetric Matrices - Eigenvalues and Graph Parameters - Eigenvalues of Regular Graphs - Eigenvalues and Expanders - Strongly Regular Graphs.

UNIT IV CONNECTEDNESS IN DIGRAPHS 9

Digraphs - Connected and Disconnected digraphs - Strong digraphs - Digraphs and matrices.

UNIT V TOURNAMENTS 9

Properties of tournaments - Hamiltonian tournaments - Score Sequences.

TOTAL : 45 PERIODS

OUTCOME

- At the end of the course, the students would be able to understand and deal with research problems related to Eigen values of graphs, extremal graphs, Ramsay theory and digraphs.

TEXT BOOKS

1. Bezhad M., Chartrand G., Lesneik Foster L., "Graphs and Digraphs", Wadsworth International Group, 1981.
2. Douglas B. West, "Introduction to Graph Theory", Prentice Hall of India, 2005.

REFERENCES

1. Bela Bollabas, "Extremal Graph Theory", Dover Publications, 2004.
2. Jorgen Bang-Jensen and Gregory Gutin, "Digraphs – Theory, Algorithms and Applications", Springer-Verlag, London, 2010.

MT7003 **ALGORITHMIC GRAPH THEORY** **L T P C**
3 0 0 3

OBJECTIVE

- To introduce the fundamental and standard graph algorithms on graph structures and graph parameters and to introduce the computational complexity of intractable graph problems.

UNIT I INTRODUCTION TO GRAPHS AND ALGORITHMIC COMPLEXITY 9

Introduction to graphs - Introduction to algorithmic complexity - Adjacency matrices and Adjacency lists - Depth first searching - Optimum weight spanning trees - Optimum branching - Enumeration of spanning-trees - Fundamental of circuits of graphs - Fundamental cut-sets of a graph - Connectivity.

UNIT II PLANAR GRAPHS AND NETWORK FLOW 9

Basic properties of planar graphs - Genus, crossing-number and thickness - Characterizations of planarity - Planarity testing algorithm - Networks and flows - Maximizing the flow in a network - Menger's theorems and connectivity - Minimum cost flow algorithm.

UNIT III GRAPH TRAVERSALS AND MATCHINGS 9

Matching - Maximum matching - Perfect Matching - Maximum-Weight matching - Eulerian graphs - Finding Eulerian circuits. Counting Eulerian circuits - Chinese postman problem - Hamiltonian tours - Some elementary existence theorems - Finding all Hamiltonian tours by matricial products - Traveling salesman problem.

UNIT IV GRAPH COLOURING 9

Dominating sets, independent sets and cliques - Edge Coloring - Vertex Coloring - Chromatic polynomials - Five colour theorem - Four colour theorem.

UNIT V GRAPH PROBLEMS AND INTRACTABILITY 9

Introduction to NP - Completeness - Classes P and NP - NP - Completeness and Cook's theorem. - Problems of Vertex cover - Problem of Independent set and clique - Problems of Hamiltonian paths and circuits and the traveling salesman problem - Problems concerning the coloring of graphs.

TOTAL : 45 PERIODS

OUTCOME

- At the end of the course, the students would be able to understand the design principles, methods to analyze the efficiency as well as the correctness of graph algorithms and most importantly, the students will be able to understand the computational challenges in designing efficient graph algorithms and will be able to deal with research problems on graph algorithms.

TEXTBOOK

1. Gibbon. A., "Algorithmic Graph Theory", Cambridge University Press, 1999.

REFERENCES

1. Douglas B. West, "Introduction to Graph Theory", Prentice Hall of India, 2002.
2. Bondy J.A. and Murthy U.S.R., "Graph Theory with Applications", Fifth Printing, Elsevier Science Publishing Co. Inc.,1982.

MT7004	ANALYSIS OF HEAT AND MASS TRANSFER	L T P C
		3 0 0 3

OBJECTIVE

- To understand the basic concept of heat and mass transfer, derivation of boundary layer equations to compute heating / cooling times and to find the temperature and velocity fields and heat fluxes in a material domain.

UNIT I FLOW ALONG SURFACES AND IN CHANNELS 9

Boundary layer and turbulence - Momentum equation - Laminar flow boundary layer equation - Plane plate in longitudinal flow - Pressure gradients along a surface – Exact solutions for a flat plate.

UNIT II FORCED CONVECTION IN LAMINAR FLOW 9

Heat flow equation - Energy equation - Plane plate in laminar longitudinal flow - Arbitrarily varying wall temperature - Exact solutions of energy equation.

UNIT III FORCED CONVECTION IN TURBULENT FLOW 9

Analogy between momentum and heat transfer - Flow in a tube - Plane plate in turbulent longitudinal flow - Recent developments in the theory of turbulent heat transfer.

UNIT IV FREE CONVECTION 9

Laminar heat transfer on a vertical plate and horizontal tube - Turbulent heat transfer on a vertical plate - Derivation of the boundary layer equations - Free convection in a fluid enclosed between two plane walls - Mixed free and forced convection.

UNIT V MASS TRANSFER 9

Diffusion - Flat plate with heat and mass transfer - Integrated boundary layer equations of mass transfer - Similarity relations for mass transfer - Evaporation of water into air.

TOTAL: 45 PERIODS

OUTCOME

- Heat transfer theory is introduced to understand the basic concepts of thermodynamics, physical transport phenomena, physical and chemical energy dissipation, additional mathematical modeling and experimental tests.

TEXTBOOKS

1. E.R. G. Eckert and R.M. Drake, “Heat and Mass Transfer”, Tata McGraw Hill Publishing Co., New Delhi, Second Edition, 1979.
2. Frank. P. Incropera & P. Dewitt.” Fundamentals of Heat and Mass Transfer”, John Wiley & Sons,1998.

REFERENCES

1. Gebhart B., “Heat Transfer”, Mc Graw Hill Publishing Co., New York, 1971.
2. Schlichting. H.and Gersten.K, ”Boundary Layer Theory”, Springer – Verlag, Eighth Edition, New Delhi, 2004.

MT7005	APPROXIMATION THEORY	L T P C
		3 0 0 3

OBJECTIVE

- To introduce the basic concepts of approximation theory and its applications.

UNIT I APPROXIMATION IN NORMED LINEAR SPACES 9

Existence - Uniqueness - convexity - Characterization of best uniform approximations - Uniqueness results - Haar subspaces - Approximation of real valued functions on an interval.

UNIT II CHEBYSHEV POLYNOMIALS 9

Properties - More on external properties of Chebyshev polynomials - Strong uniqueness and continuity of metric projection - Discretization - Discrete best approximation.

UNIT III INTERPOLATION 9

Introduction-Algebraic formulation of finite interpolation - Lagrange’s form - Extended Haar subspaces and Hermite interpolation - Hermite - Fejer interpolation.

UNIT IV BEST APPROXIMATION IN NORMED LINEAR SPACES 9

Introduction - Approximative properties of sets - Characterization and Duality.

UNIT V PROJECTION 9

Continuity of metric projections - Convexity, Solarity and Cheyshevity of sets - Best simultaneous approximation.

TOTAL : 45 PERIODS

TEXTBOOK

1. Hrushikesh N. Mhaskar and Devidas V. Pai., "Fundamentals of approximation theory", Narosa Publishing House, New Delhi, 2000.

REFERENCES

1. Ward Cheney and Will light, "A course in approximation theory", Brooks / Cole Publishing Company, New York, 2000.
2. Cheney E.W.," Introduction to approximation theory", Tata McGraw Hill Pvt. Ltd., New York, 1966.
3. Singer I.,"Best Approximation in Normed Linear Spaces by element of linear subspaces", Springer-Verlag, Berlin,1970.

MT7006 BOUNDARY LAYER THEORY

L	T	P	C
3	0	0	3

OBJECTIVE

- To give a comprehensive overview of boundary layer theory and its application to all areas of fluid mechanics with emphasis on the flow past bodies.

UNIT I DERIVATION AND PROPERTIES OF NAVIER-STOKES EQUATIONS 9

Description of flow fields - Continuity and momentum equations - General stress state - State of deformation - Relation between stresses and deformation - Stokes hypothesis - Derivation of N-S equations - Similarity laws - Limiting cases.

UNIT II EXACT SOLUTIONS OF NAVIER - STOKES EQUATIONS 9

Steady plane flows- Couette - Poiseuille flows - Plane stagnation point flow - Steady axisymmetric flows - Hagen - Poiseuille flow - Flow between two concentric rotating cylinders - Axisymmetric stagnation flow - First and second Stokes problems.

UNIT III PROPERTIES AND EXACT SOLUTIONS OF BOUNDARY LAYER EQUATIONS 9

Boundary layer equations - Wall friction, separation and displacement - Dimensional Representation - Friction drag - Plate boundary layer- Compatibility conditions at the wall - Similar solutions of the boundary layer equations - Integral relations of the boundary layer.

UNIT IV APPROXIMATE METHODS FOR SOLVING BOUNDARY LAYER EQUATIONS 9

Integral methods - Comparison between approximate and exact solutions - Boundary layer control - Continuous suction and blowing- Two dimensional and Axisymmetric boundary layers.

UNIT V FUNDAMENTALS OF TURBULENT FLOWS 9

Turbulent flow - Introduction - Mean motion and fluctuations - Basic equations for the mean motion - Boundary layer equations for plane flows - Prandtl's mixing length theory.

TOTAL : 45 PERIODS

OUTCOME

- To familiarize the student with laminar transitional, boundary layers and free sheer flows.

TEXTBOOK

1. Schlichting.H and Gersten. K, “Boundary Layer Theory”, Springer- Verlag, Eighth Edition, New Delhi, 2004.

REFERENCES

1. Batchelor. G.K. “ An introduction to Fluid Dynamics” ,Cambridge University Press,1979.
2. Yuan. S.W. ,“Foundations of Fluid Mechanics”, Prentice- Hall of India, New Delhi, 1988.

MT7007	**DATA STRUCTURES**	**L T P C**
		3 0 0 3

OBJECTIVE

- The emphasis of this course is on the organization of information, the implementation of common data structures such as arrays, stacks, queues, linked lists, binary trees, heaps, balanced trees and graphs. The course explores the implementation of these data structures (both array-based and linked representations) and examines classic algorithms that use these structures for tasks such as sorting, searching and hashing.

UNIT I STACKS AND RECURSION 9

Arrays: Array as an ADT, One-dimensional Arrays, Two-dimensional Array and Muti-dimensional Arrays - Structures and Unions - Stacks in C: Definition, Representation, Infix to Postfix conversion, Evaluating Postfix expression - Recursion in C.

UNIT II QUEUES AND LISTS 9

Queue and its sequential representation, Linked lists : Operations on Linked list, Linked Implementation of stack and queue, Lists in C, Circular linked lists.

UNIT III TREES 9

Binary Trees: Operations on Binary tree, Applications - Binary tree representation - Representing Lists as binary trees - Trees and their Applications.

UNIT IV SORTING & SEARCHING 9

Sorting: General background - Exchange sorts - Selection and Tree sorting - Insertion sorts - Merge and Radix sorts. Searching : Basic search Technique - Sequential search, Indexed Sequential search and Binary Search - Tree searching.

UNIT V GRAPH AND THEIR APPLICATIONS 9

Graphs - Representation and their Application - Linked Representation of Graphs - Graph Traversal: DFS - BFS and Spanning Forest.

TOTAL: 45 PERIODS

OUTCOMES

- Students will be able to understand the abstract properties of various data structures.
- Students will be able to implement data structures in more than one manner and recognize the advantages and disadvantages of the same in different implementations.
- Students will be able to compare the efficiency of algorithms in terms of both time and space.

TEXTBOOKS

1. Langsam.Y, Augenstein, M. and Tanenbaum, A.M., "Data Structures using C and C++", Prentice Hall of India, New Delhi, 2002.
2. Michael T. Goodrich, Roberto Tamassia, David M. Mount,"Data Structures and Algorithms in C++", Wiley, Second Edition, January, 2011.

REFERENCES

1. Kruse C.L., Lenny B.P. and Tonto C.L., "Data Structures and Program Design in C", Prentice Hall of India, 1995.
2. Ellis Horowitz, Sartaj Sahni and Dinesh Mehta, "Fundamentals of Data Structures in C++", Galgotia Publications, 1999.
3. Larry R Nyhoff, "ADTs, Data Structures and Problem Solving with C++", Pearson Education, Second Edition, 2005.
4. Michael Main and Walter Savitch, " Data Structures and Other Objects using C++", Addison Wesley, Fourth Edition, 2010.

MT7008	DESIGN AND ANALYSIS OF ALGORITHMS	L T P C
		3 0 0 3

OBJECTIVES

- Analyze the asymptotic performance of algorithms.
- Write rigorous correctness proofs for algorithms.
- Demonstrate a familiarity with major algorithms and data structures.
- Apply important algorithmic design paradigms and methods of analysis.

UNIT I ANALYZING ALGORITHMS 7

Algorithms – Analyzing algorithms – Designing algorithms – Growth of functions – Recurrences.

UNIT II SORTING 8

Insertion sort – Quick sort – Divide and Conquer – Mergesort – Heapsort – Lower bounds for sorting.

UNIT III GRAPH ALGORITHMS 11

Representations of graphs – Breadth-first search – Depth-first search – Minimum spanning tree – The algorithms of Kruskal and Prim – Shortest paths – Dijkstra's algorithm – Bellman and Ford algorithm.

UNIT IV STRING MATCHING 6

The naïve string-matching algorithm – String matching with finite automata – The Knuth-Morris – Pratt algorithm.

UNIT V POLYNOMIALS, MATRICES AND NP COMPLETENESS 13

Representation of polynomials – Fast Fourier Transform – Polynomial time – The complexity class NP – NP completeness – Reducibility – NP complete problems.

TOTAL : 45 PERIODS

OUTCOMES

- Explain the major graph algorithms and their analyses.
- Explain the different ways to analyze randomized algorithms.
- Describe the divide-and-conquer paradigm and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize divide-and-conquer algorithms. Derive and solve recurrences describing the performance of divide-and-conquer algorithms.

TEXTBOOK

1. Cormen T.H., Leiserson C.E. and Rivest R.L., "Introduction to Algorithms", 2nd Edition, Prentice Hall of India, New Delhi, 2004.
   Chapters 2.3, 6.7, 23: Sections: 1.1, 4.1 to 4.3, 8.1, 22.1to 23.3, 24.1, 24.3, 32.1, 32.3, 32.4, 30.1, 30.2, 34.1, to 34.3, 34.5.1, 34.5.4.

REFERENCES

1. Baase S., "Computer Algorithms: Introduction to Design and Analysis", 2nd Edition, Addison and Wesley, 1993.
2. Levitin A., "Introduction to the Design & Analysis of Algorithms", Pearson Education (Asia) Pvt. Ltd., New Delhi, 2003.

MT7009	**DISCRETE MATHEMATICS**	**L T P C**
		3 0 0 3

OBJECTIVE

- To strengthen the student's logical and analytical ability to deal with the generality and abstraction of mathematical principles and to introduce the fundamental counting and combinatorial methods, Boolean optimization methods, Number theoretical concepts to d eal with Algorithms and Combinatorial Circuits.

UNIT I LOGIC 9

Propositions - Implications - Equivalence - Normal Forms - Predicates and Quantifiers - Nested Quantifiers - Methods of Proof - Mathematical Induction.

UNIT II NUMBER THEORY 9

The Integers and Division - Integers and Algorithms - Applications of Number Theory.

UNIT III COUNTING 9

The Basis of Counting - The Pigeonhole Principle - Permutations and Combinations - Binomial Coefficients - Generalized Permutations and Combinations - Generating Permutations and Combinations - Inclusion - Exclusion - Applications of Inclusion - Exclusion.

UNIT IV RECURRENCE RELATIONS 9

Solving Recurrence Relations - Divide-and-Conquer Algorithms and Recurrence Relations - Generating Functions.

UNIT V BOOLEAN ALGEBRA 9

Boolean Functions - Representing Boolean Functions - Logic Gates - Minimization of Circuits.

TOTAL: 45 PERIODS

OUTCOME

- The students would be able to validate the logical arguments and understand the generalization and abstract of Mathematical concepts would be able to apply and the combinatorial methods, Boolean optimization methods to solve mathematical as well as computer science problems.

TEXTBOOK

1. Rosen K.H., "Discrete Mathematics and its Applications", Tata McGraw-Hill Publishing Company Ltd., New Delhi, Seventh Edition, 2011.

REFERENCES

1. Scheincreman E.R., "Mathematics – A Discrete Introduction", Brooks/Cole: Thomson Asia Pvt. Ltd., Singapore, 2013.
2. Grimaldi R.P., "Discrete and Combinatorial Mathematics", Pearson Education Pvt. Ltd., Singapore, Fifth Edition, 2004.

MT7010 FINITE ELEMENT METHOD L T P C
3 0 0 3

OBJECTIVE

- The aim of the course is to make the students understand the Finite element method and its implementation issues.

UNIT I INTEGRAL FORMULATIONS AND VARIATIONAL METHODS 9

Weighted integral and weak formulations of boundary value problems - Rayleigh-Ritz method - Method of weighted residuals.

UNIT II FINITE ELEMENT ANALYSIS OF ONE - DIMENSIONAL PROBLEMS 9

Discretization of the domain - Derivation of element equations - Connectivity of elements - Imposition of boundary conditions - Solution of equations.

UNIT III EIGENVALUE AND TIME DEPENDENT PROBLEMS IN ONE DIMENSION 9

Formulation of eigenvalue problem - Finite element models - Applications of semi discrete finite element models for time-dependent problems - Applications to parabolic and hyperbolic equations.

UNIT IV FINITE ELEMENT ANALYSIS OF TWO- DIMENSIONAL PROBLEMS 10

Interpolation functions - Evaluation of element matrices - Assembly of element equations - Imposition of boundary conditions - Solution of equations - Applications to parabolic and hyperbolic equations.

UNIT V FINITE ELEMENT ERROR ANALYSIS 8

Interpolation Functions - Numerical Integration and Modeling Considerations - Various measures of errors - Convergence of solution - Accuracy of solution.

TOTAL: 45 PERIODS

OUTCOMES

- To get exposed to the implementation issues of Finite Element Method for one-dimensional and two- dimensional problems.
- To acquaint the students with various formulations and implementation of steady state and time dependent partial differential equations.

TEXTBOOK

1. Reddy J.N., "An Introduction to the Finite Element Method", Tata Mc-Graw Hill, New Delhi, Third Edition, 2005.

REFERENCES

1. Buchanen G.R. and Rudhramoorthy R., "Finite Element Analysis", Schaum's Outline Series, Tata McGraw Hill, New Delhi, 2006.
2. Huttan D.V., "Fundamentals of Finite Element Analysis", Tata McGraw Hill, New Delhi, 2005.

MT7011 **FINITE VOLUME METHOD** **L T P C**
3 0 0 3

OBJECTIVE

- The aim of the course is to make the students understand the Finite volume method for solving partial differential equations arising in fluid dynamics.

UNIT I CONSERVATION LAWS AND BOUNDARY CONDITIONS 9

Governing equation of fluid flow: Mass - Momentum and Energy equations - Equation of state; Navier-Stokes equations for a Newtonian fluid - Conservative form of equations of fluid flow - Differential and integral forms of the transport equation - Classification of PDE's and fluid flow equations - Viscous fluid flow equations - Transonic and supersonic compressible flows.

UNIT II FINITE VOLUME METHOD FOR DIFFUSION & CONVECTION-DIFFUSION PROBLEMS 9

FVM for Diffusion Problems: one-dimensional steady sate diffusion - Two-dimensional diffusion and three-dimensional diffusion problems; FVM for Convection-Diffusion problems: one-dimensional steady state convection- diffusion - central differencing schemes for one - Dimensional convection-diffusion - Upwind differencing scheme - Hybrid differencing scheme - Higher-order differencing scheme for convection - Diffusion problems - TVD schemes.

UNIT III SOLUTION ALGORITHMS FOR PRESSURE-VELOCITY LINKED EQUATIONS 9

Staggered grid - momentum equations - SIMPLE, SIMPLER, SIMPLEC algorithms – PISO algorithm - Solution of discretised equation: Multigrid techniques.

UNIT IV FINITE VOLUME METHOD FOR UNSTEADY FLOWS 9

One-dimensional unsteady heat conduction: Explicit - Crank-Nicolson - fully implicit schemes - Implicit method for two and three dimensional problems - transient convection - Diffusion equation and QUICK differencing scheme - Solution procedures for unsteady flow calculations and implementation of boundary conditions.

UNIT V METHOD WITH COMPLEX GEOMETRIES 9

Body-fitted co-ordinate grids for complex geometries - Cartesian Vs. Curvilinear grids difficulties in Curvilinear grids - Block-structured grids - Unstructured grids and discretisation in unstructured grids - Discretisation of the diffusion term - Discretisation of convective term - Treatment of source terms - Assembly of discretised equations - Pressure-velocity coupling in unstructured meshes - Staggered Vs. co-located grid arrangements - Face velocity interpolation method to unstructured meshes.

TOTAL: 45 PERIODS

OUTCOMES

- Basic concepts on governing equations on fluid flow are discussed.
- This course will emphasize on the finite volume methods for diffusion, convection-diffusion, unsteady flows and problems with complex geometries.
- This course will also emphasize on SIMPLE, SIMPLER and PISO algorithms.

TEXTBOOK

1. Versteeg H.K. and Malalasekera W. "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", Pearson Education, New Delhi, Second Edition, 2008.

REFERENCES

1. Ferziger J.H and Peric. M, "Computational methods for Fluid Dynamics", Springer (India), New Delhi, Third Edition, 2005.
2. Chung T.J., "Computational Fluid Dynamics", Cambridge University Press, 2002.
3. Suhas V. Patankar, " Numerical Heat Transfer and Fluid Flow", Taylor & Francis, 2007.

MT7012 **FIXED POINT THEORY** **L T P C**
3 0 0 3

OBJECTIVE

- To identify all self-maps in which at least one element is left invariant.

UNIT I METRIC CONTRACTION PRINCIPLES 9

Banach's Contraction principle - Further Extension of Banach's principle - The Caristis - Ekeland Principle - Equivalents of the Caristi-Ekeland Principle - Set valued contractions - Generalized contractions.

UNIT II HYPERCONVEX SPACES AND NORMAL STRUCTURES IN METRIC SPACES 10

Hyperconvexity - Properties of hyperconvex spaces - A fixed point theorem - Approximate fixed points. Normal structures in Metric spaces: A fixed point theorem - Structure of the fixed point set - Fixed point set structure - Separable case.

UNIT III CONTINUOUS MAPPING IN BANACH SPACES 10

Brouwer's theorem - Further comments on Brouwer's theorem - Schauder's Theorem - Stability of Schauder's Theorem - Leray-Schauder degree - Condensing mappings - Continuous mappings in hyperconvex spaces.

UNIT IV METRIC FIXED POINT THOERY 8

Contraction mappings - Basic theorems for nonexpansive mappings - Structure of the fixed point set - Asymptotically regular mappings - Set valued mappings.

UNIT V ASYMPTOTIC NONEXPENSIVENESS AND DEMICLOSEDNESS 8

Some fixed point theorem - Asympotitically nonexpansive mappings - The demiclosedness principle.

TOTAL : 45 PERIODS

OUTCOME

- The student will be able to apply fixed point theory in various branches of applied mathematics.

TEXTBOOK

1. Mohamed A. Khamsi & William A. Kirk, "An Introduction to Metric Spaces and Fixed Point Theory", John Wiley & Sons, New York, 2001.

REFERENCES

1. Zeidler E., "Nonlinear Functional Analysis and its applications", Vol. I, Springer-Verlag New York, 1986.
2. Deimling K., "Nonlinear Functional Analysis", Springer–Verlag, New York, 1985.
3. Smart D.R.," Fixed Point Theory", Cambridge University Press, 1980.
4. Istratescu V. I., "Fixed Point theory: An Introduction", D. Reidel Publishing Company, Boston, 1981.

MT7013 **FLUID MECHANICS** **L T P C**
3 0 0 3

OBJECTIVE

- Fluid Mechanics is a branch of mechanics that deals with the analysis of the kinematics and the mechanical behaviour of fluids.

UNIT I KINEMATICS OF FLUIDS IN MOTION 9

Real and Ideal fluids – Velocity - Acceleration – Streamlines – Pathlines – Steady & unsteady flows – Velocity potential – Vorticity vector – Local and particle rates of change – Equation of continuity – Conditions at a rigid boundary.

UNIT II EQUATIONS OF MOTION OF A FLUID 9

Pressure at a point in a fluid – Boundary conditions of two inviscid immiscible fluids – Euler's equations of motion – Bernoulli's equation – Some potential theorems – Flows involving axial symmetry.

UNIT III TWO DIMENSIONAL FLOWS 9

Two-Dimensional flows – Use of cylindrical polar co-ordinates – Stream function, complex potential for two-dimensional flows, irrotational, incompressible flow – Complex potential for standard two-dimensional flows –Two dimensional image systems – Milne-Thomson circle theorem – Theorem of Blasius.

UNIT IV CONFORMAL TRANSFORMATION AND ITS APPLICATIONS 9

Use of conformal transformations – Hydrodynamical aspects of conformal mapping - Schwarz Christoffel transformation – Vortex rows.

UNIT V VISCOUS FLOWS 9

Stress – Rate of strain – Stress analysis – Relation between stress and rate of strain – Coefficient of viscosity – Laminar flow – Navier-Stokes equations of motion – Some problems in viscous flow.

TOTAL: 45 PERIODS

OUTCOME

- This course emphasises that the student should be familier with the behaviour of fluid particles. The key mathematical concept of fluid mechanics is the tensor and it convects the mathematical notion of a tensor to the physics of fluids.

TEXTBOOK

1. Frank Chorlton, "Textbook of Fluid Dynamics", CBS Publishers, New Delhi, 1985. (Sections: 2.1 - 2.10, 3.1 – 3.9, 5.1 – 5.12, 8.1 – 8.10, 8.15)

REFERENCES

1. Batchelor G.K., "An Introduction to Fluid Dynamics", Cambridge University Press, 1993.
2. White F.M., "Fluid Mechanics", McGraw-Hill, 2000.
3. Milne Thomson L.M., "Theoretical Hydrodynamics", Macmillan, 1967.
4. White F.M., "Viscous Fluid Flow", McGraw-Hill, 1991.

MT7014	FORMAL LANGUAGES AND AUTOMATA THEORY	L T P C
		3 0 0 3

OBJECTIVE

- To introduce the students to concepts in automata theory and theory of computation, identify different formal language classes and their relationships, design grammars and recognizers for different formal languages, prove or disprove theorems in automata theory using its properties and determine the decidability and intractability of computational problems.

UNIT I REGULAR SETS AND FINITE STATE AUTOMATA 9

Finite state automata - Deterministic and non-deterministic model - Languages accepted by Finite State Automata - Regular Expression - Pumping Lemma for regular set.

UNIT II CONTEXT FREE LANGUAGES 9

Grammar - Context Free Grammars - Derivation trees - Simplification of context - Free grammar (only Construction and no proof of equivalence of grammars) - Chomsky normal Form - Greibach Normal Form.

UNIT III PUSH DOWN AUTOMATA AND PROPERTIES AND CONTEXT FREE LANGUAGES 9

Pushdown automata - Push down automata and Context free languages - Pumping lemma for context free languages.

UNIT IV TURING MACHINE AND UNDECIDEABILITY 9

Turing Machine model - Computational languages and functions - Modifications of Turing machines (only description, no proof for theorems on equivalence of the modification) - Problems - Properties of recursive and recursively enumerable languages - Universal Turing Machine and the undecidable problem.

UNIT V THE CHOMSKY HIERARCHY 9

Regular grammar - Unrestricted grammar - Context Sensitive languages - Linear bounded automata - Relation between classes of languages.

TOTAL: 45 PERIODS

OUTCOME

- At the end of the course, the students would be able to develop understanding of finite state systems and their language generations, grammars and their language generations and equivalence between these two language generations, able to understand the Chomsky Hierarchy of formal languages, develop understanding of the principles of computability and complexity including decision problems, halting problems and basic complexity classes such as P and NP. Understand the limits of computation.

TEXTBOOK

1. Hopcroft J.E. and Ullman J.D. "Introduction to Automata Theory, Languages and Computation", Narosa Publishing House, 2002.

REFERENCES

1. Hopcroft, J.E., Rajeev Motwani and Ullman, J.D. "Introduction to Automata Theory, Languages, and Computation", Pearson Education, Second Edition, 2000.
2. Mishra K.L.P and Chandrasekaran. N, "Theory of Computer Science: Automata, Languages and Computation", Prentice Hall of India, Third Edition, 2008.
3. Peter Linz, "An Introduction to Formal Languages and Automata", Narosa Publishing House, Fourth Edition, 2012.

MT7015	FUNCTIONAL ANALYSIS AND ITS APPLICATIONS TO PARTIAL DIFFERENTIAL EQUATIONS	L T P C
		3 0 0 3

OBJECTIVE

- The aim of the course is to make the students understand the functional analytic concepts and techniques used in Partial Differential Equations.

UNIT I DISTRIBUTION THEORY 9

Distributions, operations with distributions, support and singular support, convolutions, fundamental solutions, Fourier transform, tempered distributions.

UNIT II SOBOLEV SPACES 9

Basic properties, approximation by smooth functions and consequences, imbedding theorems, Rellich - Kondrasov compactness theorem, fractional order spaces, trace spaces, dual spaces, trace theory.

UNIT III WEAK SOLUTIONS OF ELLIPTIC EQUATIONS 9

Abstract variational results (Lax-Milgram lemma, Babuska- Brezzi theorem), existence and uniqueness of weak solutions for elliptic boundary value problems (Dirichlet, Neumann and mixed problems), regularity results.

UNIT IV GALERKIN METHODS 9

Galerkin method, maximum principles, eigenvalue problems, introduction to the mathematical theory of the finite element method.

UNIT V EVOLUTION EQUATIONS 9

Unbounded operators, exponential map, C_0-semigroups, Hille-Yosida theorem, contraction semigroups in Hilbert spaces, applications to the heat, wave and Schrodinger equations, inhomogeneous problems.

TOTAL: 45 PERIODS

OUTCOME

- The course, apart from providing a through understanding of the functional analytic concepts and techniques used in partial differential equations, will enable them to solve the partial differential equations of various problems arising in Science and Engineering.

TEXTBOOK

1. Kesavan, S., “Topics in Functional Analysis and Applications”, New Age International Ltd., New Delhi, 1989, (Reprint 2008).

REFERENCES

1. Evans L. C., “Partial Differential Equations, Graduate Studies in Mathematics” 19, AMS, University Press, Hyderabad, 2009.
2. McOwen R.C., “Partial differential Equations”, Pearson Education, New Delhi, 2003.

MT7016	**FUZZY SET THEORY**	**L T P C**
		3 0 0 3

OBJECTIVES

- To define the basic ideas and entities in fuzzy set theory.
- To introduce the operations and relations on fuzzy sets.
- To learn how to compute with fuzzy sets and numbers.

UNIT I FUZZY SETS VARSUS CRISP SETS 9

Fuzzy sets-Basic types - Fuzzy sets - Basic concepts - Additional properties of ~ -cuts - Representations of fuzzy sets - Extension principle for fuzzy sets.

UNIT II OPERATIONS ON FUZZY SETS 9

Types of operations - Fuzzy complements - Fuzzy intersections: t-norms - Fuzzy unions: t- co-norms - Combinations of operations.

UNIT III FUZZY ARITHMETIC 9

Fuzzy numbers - Linguistic variables - Arithmetic operations on Intervals - Arithmetic operations on fuzzy numbers.

UNIT IV FUZZY RELATIONS 10

Crisp and fuzzy relations - Projections and cylindric extensions - Binary fuzzy relations - Binary relations on a single set - Fuzzy equivalence relations - Fuzzy compatibility relations - Fuzzy ordering relations - Sup-i composition and inf-w_i compositions of Fuzzy relations.

UNIT V FUZZY RELATION EQUATIONS 8

Partition - Solution method - Fuzzy relation equations based on sup-i compositions and inf-w_i compositions.

TOTAL: 45 PERIODS

OUTCOME

- To use fuzzy logic based methodology for retrieval of temporal cases in a case-based reasoning (CBR) system, etc.

TEXTBOOK

1. George J. Klir and Yuan B., "Fuzzy Sets and Fuzzy Logic, Theory and Applications", Prentice Hall of India Pvt. Ltd., 2010.

REFERENCES

1. Dubois D. and Prade H., "Fuzzy sets and systems, Theory and Applications", Press, New York,1980.
2. Kaufmann A.," Introduction to the theory of Fuzzy Subsets", Vol. I, Fundamental Theoretical Elements, Academic Press, New York,1975.
3. Ganesh, M.," Introduction to Fuzzy sets and Fuzzy logic", Prentice Hall of India Pvt. Ltd., 2009.

MT7017	GEOMETRIC FUNCTION THEORY	L T P C
		3 0 0 3

OBJECTIVE

- The advanced level of Complex Analysis have been introduced and an expertise treatment is provided on Subordination, General Extremal problems and Integral transforms.

UNIT I ELEMENTARY THEORY OF UNIVALENT FUNCTIONS 9

The Area theorem - Growth and Distortion Theorems - Coefficient Estimates - Convex and Starlike functions - Close to Convex functions - Spirallike functions - Typically Real functions**.**

UNIT II VARIATIONAL METHODS 9

A Primitive Variational Method - Growth of Integral Means - Odd Univalent functions - Asymptotic Bieberbach Conjecture**.**

UNIT III SUBORDINATION 9

Basic Principles - Coefficient Inequalities - Sharpened Forms of the Schwartz Lemma - Majorization - Univalent Subordinate Functions.

UNIT IV GENERAL EXTREMAL PROBLEMS 9

Functionals of Linear Spaces - Representation of Linear Functionals - Extreme Points and Support Points- Properties of Extremal Functions - Extreme Points of S, Extreme Points of ∑.

UNIT V COEFFICIENT CONJECTURE **9**

Preliminaries – Proof of the Coefficient Conjecture.

TOTAL: 45 PERIODS

OUTCOME

- The course equips the students with theory of Univalent functions and related mathematical concepts based on the same.

TEXTBOOKS

1. Peter L. Duren, “Univalent Functions”, Springer Verlag, May 1983.
2. A.W. Goodman, “Univalent Functions”, Vol. 1, 11, Polygonal Publishing House, 1983.

REFERENCE

1. Louis de Branges, "A proof of the Bieberbach conjecture", Acta Mathematica 154 (1): 137–152 (1985).

MT7018 **GRAPH THEORY** **L T P C**
3 0 0 3

OBJECTIVE

- To introduce the students the fundamental and structural graph theory through structural properties of various classes of graphs and different graph parameters.

UNIT I INTRODUCTION **9**

Graphs and simple graphs - Graph isomorphism - Incidence and adjacency matrices - subgraphs - Vertex degrees - Paths and connection - Cycles - Trees - Cut edges and bonds - Cut vertices - The Shortest Path Problem - The Connector Problem.

UNIT II CONNECTIVITIY AND TRAVERSIBILITY **9**

Connectivity - Whitney’s theorems - Blocks - Applications of connectivity - Euler’s tour - Hamilton Cycles - The Chinese Postman Problem - The Traveling Salesman Problem (only a brief introduction on these problems.)

UNIT III MATCHING **9**

Matching - Matchings and covering in bipartite graphs - Perfect matchings - Independent sets.

UNIT IV COLORING **9**

Vertex chromatic number - k-critical graphs - Brook’s theorem - Chromatic polynomials - Girth and Chromatic number.

UNIT V PLANAR GRAPHS **9**

Planar graphs - Euler’s formula - Kurtowski’s theorem - Five color theorem.

TOTAL : 45 PERIODS

OUTCOME

- The students would be able to understand the structural complexity of various graph structures and related research problems as well as their applications on real world problems. The students will also be able to understand the algorithmic aspects of the graph structures and graph parameters.

TEXTBOOK

1. Bondy J. A. and Murty U.S. R., “Graph theory with Applications”, Elsevier North-Holland 1976.

REFERENCES
1. Balakrishnan R. and Ranganathan K., “A Text Book of Graph Theory”, Springer- Verlag, 2012.
2. Bezhad M., Chartrand G. and Lesneik Foster L., “Graphs and Digraphs”, Wadsworth International Group, 1979.
3. Douglas B. West, “Introduction to Graph Theory”, Prentice Hall of India, New Delhi, 2002.
4. Harary F., “Graph Theory”, Narosa Publishing House, New Delhi, 2001.

MT7019 MATHEMATICAL ASPECTS OF FINITE ELEMENT METHOD **L T P C**
3 0 0 3

OBJECTIVE
- The aim of the course is to make the students understand the mathematical aspects of finite element method required for solving partial differential equations.

UNIT I BASIC CONCEPTS 9
Weak formulation of Boundary Value Problems - Ritz-Galerkin approximation - Error Estimates - Piecewise polynomial spaces - Finite Element Method - Relationship to Difference Methods - Local Estimates.

UNIT II SOBOLEV SPACES 9
Review of Lebesgue integration theory - Weak derivatives - Sobolev norms and associated spaces - Inclusion relations and Sobolev’s inequality - Trace Theorems - Negative norms and duality.

UNIT III VARIATIONAL FORMULATIONS 9
Review of Hilbert spaces - Projections onto subspaces and Riesz representation theorem - Symmetric and non-symmetric variational formulation of elliptic and parabolic boundary value problems - Lax-Milgram Theorem - Error estimates for General Finite Approximation.

UNIT IV CONSTRUCTION OF FINITE ELEMENT SPACE AND APPROXIMATION THEORY IN SOBOLEV SPACES 9
The Finite Element - Triangular finite elements - Lagrange element - Hermite element, Rectangular elements - Interpolant - Averaged Taylor polynomials - Error representation - Bounds for the Interpolation error - Inverse estimates.

UNIT V HIGHER DIMENSIONAL VARIATIONAL PROBLEMS 9
Higher-dimensional examples - Variational formulation and approximation of Poisson’s and Neumann equations - Coercivity of the variational problem - Elliptic regularity estimates - Variational approximations of general Elliptic and Parabolic problems.

TOTAL: 45 PERIODS

OUTCOME
- The students will be in position to tackle complex problems involving partial differential equations arising in the mathematical models of various problems in Science and Engineering by finite element techniques.

TEXTBOOKS
1. Brenner S. and Scott R., “The Mathematical Theory of Finite Element Methods”, Springer-Verlag, New York, 1994.
2. Claes Johnson, “Numerical Solutions of Partial Differential Equations by the Finite Element Method”, Cambridge University Press, Cambridge, 1987.

REFERENCES

1. Ciarlet P.G., "The Finite Element Methods for Elliptic Problems", North Holland, Amsterdam, 1978.
2. Thomee V., "Galerkin Finite Element Methods for Parabolic Problems", Lecture Notes in Mathematics, Vol.1054, Springer-Verlag, Berlin, 1984.

MT7020 MATHEMATICAL FINANCE **L T P C**
3 0 0 3

OBJECTIVE

- The principal aim of this course is to provide students with an appreciation and understanding of how the application of mathematics, particularly stochastic mathematics, to the field of finance may be used to illuminate this field and model its randomness, resulting in greater understanding and quantification of investment returns and basics of option pricing. It would also be helpful to understand the fundamentals of LP models and their duals while grasping the proof of the Arbitrage theorem.

UNIT I PROBABILITY AND RANDOM VARIABLES 9

Probability and Events - Conditional probability - Random Variables and Expected values - Covariance and Correlation - Normal Random Variables - Properties of Normal Random Variables - Central Limit theorem - Geometric Brownian Motion as a limit of simpler models - Brownian motion.

UNIT II PRESENT VALUE ANALYSIS AND ARBITRAGE 9

Interest rates - Present value analysis - Rate of return - Continuously varying interest rates - Pricing contracts via Arbitrage - An example in options pricing.

UNIT III ARBITRAGE THEOREM AND BLACK-SCHOLES FORMULA 9

The Arbitrage theorem - Multiperiod binomial model - Black-Scholes formula - Properties of Black - Scholes option cost - Delta Hedging Arbitrage Strategy - Pricing American put options.

UNIT IV EXPECTED UTILITY 9

Limitations of arbitrage pricing - Valuing investments by expected utility - The portfolio section problem - Capital assets pricing model - Rates of return - Single period and geometric Brownian motion.

UNIT V EXOTIC OPTIONS 9

Barrier options - Asian and look back options - Monte Carlo Simulation - Pricing exotic option by simulation - More efficient simulation estimators - Options with non-linear pay offs - pricing approximations via multi-period binomial models.

TOTAL: 45 PERIODS

OUTCOME

- The students would have a clear perception of the power of mathematical ideas and tools and would be able to demonstrate the application of mathematics to problems drawn from industry and financial services. Also, they would be able to describe the main equilibrium asset pricing models and perform calculations using such models; understand the relationship between investment risk and return and calculate the option prices using the studied models.

TEXTBOOK

1. Sheldon M. Ross, "An Elementary Introduction to Mathematical Finance", Cambridge University Press, Third Edition, 2011.

REFERENCES

1. Steven Roman, "Introduction to the Mathematics of finance", Springer International edition, 2004.
2. Williams, R.J., "Introduction to the Mathematics of finance", AMS, Universities Press (India) Pvt. Ltd, 2006.

MT7021	**MATHEMATICAL PROGRAMMING**	**L T P C**
		3 0 0 3

OBJECTIVE

- Introduces well known Mathematical Programming techniques like Linear Programming, Integer Programming, Non-linear Programming and Dynamic Programming from an applied point of view.

UNIT I LINEAR PROGRAMMING 9

Formulation - Graphical solution - Simplex method - Transportation and Assignment problems.

UNIT II ADVANCED LINEAR PROGRAMMING 9

Duality - Dual simplex method - Revised simplex method - Bounded variable technique.

UNIT III INTEGER PROGRAMMING 9

Cutting plane algorithm - Branch and bound technique - Applications of Integer programming.

UNIT IV NON-LINEAR PROGRAMMING 9

Classical optimization Techniques for Unconstrained and Constrained problems - Quadratic programming.

UNIT V DYNAMIC PROGRAMMING 9

Principle of optimality - Forward and backward recursive equations - Deterministic dynamic programming applications.

TOTAL: 45 PERIODS

OUTCOME

- Prepares the student to model various real life situations as Optimization problems and effect their solution through Mathematical Programming techniques.

TEXTBOOKS

1. Taha, H.A. "Operations Research: An Introduction", Pearson Education, India, Ninth Edition, 2012.
2. Ravindran A., Phillips D.T. and Solberg, J.J., "Operations Research - Principles and Practice", Wiley India Edition, Second Edition, 2007.

REFERENCES

1. Sharma, J.K. "Operations Research: Theory and Applications", Macmillan India Ltd., Third Edition, 2006.
2. Kantiswarup, P.K.Gupta and Manmohan " Operations Research" , Sultan Chand & Sons New Delhi , 2002.

MT7022 **MATHEMATICAL STATISTICS** **L T P C**
3 0 0 3

OBJECTIVE

- To teach various statistical techniques from both applied and theoretical points of view.

UNIT I SAMPLING DISTRIBUTIONS AND ESTIMATION THEORY 9

Sampling distributions - Characteristics of good estimators - Method of Moments - Maximum Likelihood Estimation - Interval estimates for mean, variance and proportions.

UNIT II TESTING OF HYPOTHESIS 9

Type I and Type II errors - Tests based on Normal, t, χ^2 and F distributions for testing of mean, variance and proportions - Tests for Independence of attributes and Goodness of fit.

UNIT III CORRELATION AND REGRESSION 9

Method of Least Squares - Linear Regression - Normal Regression Analysis - Normal Correlation Analysis - Partial and Multiple Correlation - Multiple Linear Regression.

UNIT IV DESIGN OF EXPERIMENTS 9

Analysis of Variance - One-way and two-way Classifications - Completely Randomized Design - Randomized Block Design - Latin Square Design.

UNIT V MULTIVARIATE ANALYSIS 9

Mean Vector and Covariance Matrices - Partitioning of Covariance Matrices - Combination of Random Variables for Mean Vector and Covariance Matrix - Multivariate, Normal Density and its Properties - Principal Components: Population principal components - Principal components from standardized variables.

TOTAL: 45 PERIODS

OUTCOME

- This course will be helpful for the students, who want to apply the various modern statistical tools in Science, Engineering, Industry, Operations Research, Biomedical and Public policy.

TEXTBOOKS

1. Freund J.E.," Mathematical Statistics", Prentice Hall of India, Fifth Edition, 2001.
2. Johnson R.A. and Wichern D.W., "Applied Multivariate Statistical Analysis", Pearson Education Asia, Sixth Edition, 2007.

REFERENCES

1. Gupta S.C. and Kapoor V.K.," Fundamentals of Mathematical Statistics", Sultan Chand & Sons, Eleventh Edition, 2003.
2. Devore J.L. "Probability and Statistics for Engineers", Brooks/Cole (Cengage Learning), First India Reprint, 2008.

MT7023 **NETWORKS, GAMES AND DECISIONS** **L T P C**
3 0 0 3

OBJECTIVE

- Introduces network optimization techniques, games and decision making – three important areas in OR / Optimization.

UNIT I NETWORK MODELS 9

Scope and definition of network models - Minimal spanning tree algorithm - Shortest - route problem - Maximal-flow Model.

UNIT II CPM AND PERT 9

Network representation - Critical path (**CPM**) computations - Construction of the time schedule - Linear programming formulation of **CPM** - **PERT** calculations.

UNIT III GAME THEORY 9

Optimal solution of two-person zero-sum games - Mixed strategies - Graphical solution of (2 x n) and (m x 2) games - Solution of m x n games by linear programming.

UNIT IV DECISION ANALYSIS 9

Decision making under certainty: analytic hierarchy process (**AHP**) - Decision making under risk - Decision under uncertainty.

UNIT V MARKOVIAN DECISION PROCESS 9

Scope of the Markovian decision problem - Finite stage dynamic programming model - Infinite stage model - Linear programming solution.

TOTAL: 45 PERIODS

OUTCOMES

- Helps in formulating many practical problems in the frame work of Networks.
- Identifies competitive situations which can be modeled and solved by game theoretic formulations.
- Offers interesting techniques to quantity and effectively obtain the solution of various decision making situations.

TEXTBOOK

1. Taha, H.A. “Operations Research: An Introduction”, Pearson Education India, Ninth Edition, 2012.

REFERENCES

1. Hillier F.S., Lieberman G.J., Nag, Basu, “Introduction to Operations Research”, Tata Mc-Graw Hill, New Delhi, Ninth Edition, 2011.
2. Winston W.L., “Operations Research”, Brooks/Cole Cengage Learning, Fourth Edition, 2003.

MT7024	NUMBER THEORY	L T P C
		3 0 0 3

OBJECTIVE

- To introduce the students basic number theory concepts.

UNIT I DIVISIBILITY 9

Introduction - Divisibility - Primes - The binomial theorem.

UNIT II CONGRUENCES 9

Congruences - Solutions of congruences - The chinese - Remainder theorem - Techniques of numerical calculation.

UNIT III APPLICATION OF CONGRUENCE AND QUADRATIC RECIPROCITY 9

Public - Key cryptography - Prime power moduli - Prime modulus - Primitive roots and power residues - Quadratic residues - The Gaussian reciprocity law.

UNIT IV FUNCTIONS OF NUMBER THEORY 9

Greatest integer function - Arithmetic functions - Mobius inversion formula - Recurrence functions - Combinational number theory.

UNIT V DIOPHANTINE EQUATIONS AND FAREY FRACTIONS 9

The equations ax + by = c Pythagorean triangle - Shortest examples - Farey sequences - Rational approximations.

TOTAL: 45 PERIODS

OUTCOMES

- The students will be introduced to Quadratic Residues and reciprocity.
- The students will be able to solve some diaphantine equations and some special cases of Femat's Last theorem.

TEXTBOOK

1. Niven I., Zuckerman H.S., and Montgomery H.L., "An introduction to the theory of numbers", John Wiley & Sons (Asia) Pvt., Ltd., Singapore, Fifth Edition, 2004.

REFERENCES

1. Graham R.L., Knuth D.E. and Patachink O., "Concrete Mathematics", Pearson education Asia, Second Edition, 2002.
2. Bressoud D., Wagon S., "A Course in Computational Number Theory", Key College Publishing, 2000.

MT7025 NUMBER THEORY AND CRYPTOGRAPHY L T P C
3 0 0 3

OBJECTIVE

- To Make the Mathematics Students understand the theory behind certain Cryptographic Schemes in full depth.

UNIT I INTRODUCTION TO NUMBER THEORY 9

Time estimates for doing arithmetic - Divisibility and the Euclidean algorithm - Congruences - Modular exponentiation - Some applications to factoring.

UNIT II QUADRATICS RESIDUES AND RECIPROCITY 9

Finite Fields - Multiplicative generators - Quadratic residues and reciprocity.

UNIT III CRYPTOSYSTEMS 9

Some simple crypto systems - Digraph transformations - Enciphering Matrices - Affine enchipering transformations RSA - Discrete Log - Diffie-Hellman key exchange - The Massey - Omura cryptosystem - Digital Signature standard - Computation of discrete log.

UNIT IV PRIMALITY AND FACTORING - I 9

Pseudoprimes - Strong pseudo primes - Solovay-Strassen Primality test - Miller - Rabin test - Rho method.

UNIT V PRIMALITY AND FACTORING - II **9**

Elliptic Curves - Elliptic Curve Cryptosystems - Elliptic curve primality test - Elliptic Curve factoring - Pollard's p - 1 method - Elliptic curve reduction modulo n.

TOTAL: 45 PERIODS

OUTCOMES

- The students will be introduced to number theory required for public key cryptography.
- The students will be introduced to the Mathematics behind some of the Cryptographic primitives.

TEXTBOOK

1. Neal Koblitz, "A course in Number Theory and Cryptography", Springer-Verlag, Second Edition, 1994.

REFERENCE

1. Menezes A, "Van Oorschot and Vanstone S.A, Hand book of Applied Cryptography", CRC Press, 1996.

MT7026 NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS **L T P C**
3 0 0 3

OBJECTIVE

- The aim of the course is to make the students understand the mathematical concepts of numerical methods for solving partial differential equations, their implementation and analysis.

UNIT I LINEAR SYSTEMS OF EQUATIONS **9**

Iterative methods for solving large linear systems of algebraic equations: Jacobi, Gauss-seidel and S.O.R methods - Conditions for convergence of them - Methods for accelerating convergence: Lyusternite's & Aitken's methods - Optimum acceleration parameter for S.O.R method.

UNIT II ONE DIMENSIONAL PARABOLIC EQUATIONS **9**

Explicit and Crank-Nicolson Schemes for $u_t = u_{xx}$ - Weighted average approximation - Derivative boundary conditions - Truncation errors - Consistency, Stability and convergence - Lax Equivalence theorem.

UNIT III MATRIX NORMS & TWO DIMENSIONAL PARABOLIC EQUATION **9**

Vector and matrix norms - Eigenvalues of a common tridiagonal matrix - Gerischgorin's theorems - Stability by matrix and Fourier-series methods - A.D.I. methods.

UNIT IV HYPERBOLIC EQUATIONS **9**

First order quasi-linear equations and characteristics - Numerical integration along a characteristic - Lax-Wendroff explicit method - Second order quasi-linear hyperbolic equation - Characteristics - Solution by the method of characteristics.

UNIT V ELLIPTIC EQUATIONS **9**

Solution of Laplace and Poisson equations in a rectangular region - Finite difference in Polar coordinate Formulas for derivatives near a curved boundary when using a square mesh - Discretisation error - Mixed Boundary value problems.

TOTAL: 45 PERIODS

OUTCOME

- The students will be able to apply the concepts and techniques for the solution of partial differential equations arising in various problems of Science and Engineering.

TEXTBOOK

1. Smith G.D., “Numerical Solution of P.D.E.”, Oxford University Press, New York, 1995.

REFERENCES

1. Mitchel A.R. and Griffiths S.D.F., “The Finite Difference Methods in Partial Differential Equations”, John Wiley and sons, New York, 1980.
2. Morton K.W., Mayers, D.F., “Numerical Solutions of Partial Differential Equations”, Cambridge University Press, Cambridge, 2002.
3. Iserles A., “A first course in the Numerical Analysis of Differential Equations”, Cambridge University press ,New Delhi ,2010.

MT7027 QUEUEING AND RELIABILITY MODELLING **L T P C**
3 0 0 3

OBJECTIVES

- To get exposed to various queueing models available in the literature and some of their real time applications.
- To familiarize with the concept of system reliability, availability and maintainability which opens up new avenues for research.

UNIT I MARKOVIAN QUEUES 9

Steady State Analysis - Single and multiple channel queues - Erlang’s formula - Queues with unlimited service - Finite source queues - Transient behavior - Busy period analysis.

UNIT II ADVANCED MARKOVIAN QUEUES 9

Bulk input model - Bulk service model - Erlangian Models - Priority queue Discipline.

UNIT III NON-MARKOVIAN QUEUES 9

M/G/1 queueing model - Pollaczek-Khintchine formula - Steady-state system size probabilities - Waiting time distributions - Generalization of Little’s formula - Busy period analysis.

UNIT IV SYSTEM RELIABILITY 9

Reliability and hazard functions - Exponential, normal, weibull and Gamma failure distributions - Time-dependent hazard models, Reliability of series and parallel systems, k- out-of-m systems.

UNIT V MAINTAINABILITY AND AVAILABILITY 9

Maintainability and Availability functions - Frequency of failures - Two unit parallel system with repair - k out of m systems.

TOTAL: 45 PERIODS

OUTCOME

- To acquaint the students with various mathematical techniques that help to obtain explicit analytic solution to problems arising in real world applications in both steady state and time dependent regime.

TEXTBOOKS

1. Gross D. and Harris C.M., “Fundamentals of Queueing Theory”, John Wiley and Sons, New York, 1998.
2. Balagurusamy E., “Reliability Engineering”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1984.

REFERENCES
1. Govil A.K., “Reliability Engineering”, Tata-McGraw Hill Publishing Company Ltd., New Delhi, 1983.
2. Charless E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill, New Delhi, 2000.
3. Kleinrock. L., “Queueing Systems: Volume 1”, John Wiley and Sons, Newyork, 1975.
4. Medhi J, ”Stochastic models of Queueing Theory”, Academic Press, Elsevier, Amsterdam, 2003.

MT7028 STOCHASTIC PROCESSES L T P C
3 0 0 3

OBJECTIVE

- This course aims at providing the necessary basic concepts in stochastic processes. Knowledge of fundamentals and applications of random phenomena will greatly help in the understanding of topics such as signals and systems, pattern recognition, voice and image processing and filtering theory.

UNIT I MARKOV AND STATIONARY PROCESSES 9
Specification of Stochastic Processes - Stationary Processes - Poisson Process - Generalizations - Birth and Death Processes - Martingales - Erlang Process.

UNIT II RENEWAL PROCESSES 9
Renewal processes in discrete and continuous time - Renewal equation - Stopping time - Wald’s equation - Renewal theorems - Delayed and Equilibrium renewal processes - Residual and excess life times - Renewal reward process - Alternating renewal process - Regenerative stochastic process.

UNIT III MARKOV RENEWAL AND SEMI – MARKOV PROCESSES 9
Definition and preliminary results - Markov renewal equation - Limiting behaviour - First passage time.

UNIT IV BRANCHING PROCESSES 9
Generating functions of branching processes - Probability of extinction - Distribution of the total number of progeny - Generalization of classical Galton - Watson process - Continuous time Markov branching process - Age dependent branching process.

UNIT V MARKOV PROCESSES WITH CONTINUOUS STATE SPACE 9
Brownian motion - Wiener process - Diffusion and Kolmogorov equations - First passage time distribution for Wiener process - Ornstein - Uhlenbeck process.

TOTAL: 45 PERIODS

OUTCOME

- The students would understand and characterize phenomena which evolve with respect to time in a probabilistic manner and also study advanced topics for future research involving stochastic modeling.

TEXTBOOK
1. Medhi J., “Stochastic Processes”, New Age International (P) Ltd., New Delhi, Third Edition, 2009.

REFERENCES
1. Narayan Bhat U. and Gregory K. Miller, "Elements of Applied Stochastic Processes", Wiley – Inter science, Third Edition, 2002.
2. Karlin S. and Taylor H.M., "A First Course in Stochastic Processes", Academic press, New York, Second Edition, 1975.
3. Cox D.R. and Miller H.D., "The theory of Stochastic Process", Methuen, London,1965.
4. Ross S. M. ,"Stochastic Processes", Wiley, New York, Second Edition,1996.

MT7029 THEORY OF ELASTICITY L T P C
3 0 0 3

OBJECTIVE
- Theory of elasticity is the branch of solid mechanics which deals with the stress and displacements in elastic solids by external forces or changes in temperature.

UNIT I ANALYSIS OF STRAIN 9
Deformation - Strain tensor in rectangular Cartesian coordinates - Geometric interpretation of infinitesimal strain - Rotation - compatibility of strain components - Properties of strain tensor - Strain in spherical and cylindrical polar coordinates.

UNIT II ANALYSIS OF STRESS 9
Stresses - Laws of motion - Cauchy's formula - Equations of equilibrium - Transformation of coordinates - Plane state of stresses - Cauchy's stress quadric - Shearing stress - Mohr's circle - Stress deviation - Stress tensor in general coordinates – Physical components of a stress tensor in general coordinates - Equation of equilibrium in curvilinear coordinates.

UNIT III LINEAR THEORY OF ELASTICITY 8
Generalized Hooke's law - Stress-Strain relationship for an isotropic elastic material, Basic equation of elasticity for homogeneous isotropic bodies - Boundary value problems - The problem of equilibrium and the uniqueness of solution of elasticity - Saint-Venant's principle.

UNIT IV TORSION 7
Torsion of prismatic bars - Torsion of circular - Elliptic and rectangular bars - Membrane analogy - Torsion of rectangular section and hollow thin walled sections.

UNIT V SOLUTION OF TWO AND THREE DIMENSIONAL PROBLEMS IN ELASTICITY 12
Bending of a cantilever beam - Simply supported beam with simple loadings - Semi-infinite medium subjected to simple loadings - Plane elastic waves - Rayleigh surface waves - Love waves - Vibration of an infinite isotropic solid cylinder.

TOTAL: 45 PERIODS

OUTCOME
- The purpose of study is to check the sufficiency of strength stiffness, and stability of structural and machine elements. It focuses on the practical application of the theoretical results.

TEXTBOOKS
1. Hetnarski R.B. and Ignaczak J. "Mathematical Theory of Elasticity", Taylor & Francis, London, 2004.
2. Sokolnikoff I.S. "Mathematical Theory of Elasticity", Tata-McGraw Hill, New Delhi, 1974.
3. Achenbach J.D. "Wave Propagation in Elastic Solids", North-Holland Pub. Co. Amsterdam, 1973.

REFERENCES
1. Srinath L.S., "Advanced Mechanics of Solids", Tata McGraw Hill, New Delhi, Third Edition, 2008.
2. Fung Y.C., "Foundations of Solid Mechanics", Prentice Hall Inc., New Jercy, 1965.

MT7030 **THEORY OF WAVELETS** **L T P C**
3 0 0 3

OBJECTIVE

- To revise Fourier Analysis and to introduce the notions of wavelet transforms, Time frequency analysis, multi-resolution analysis and wavelets. Also to introduce the more specialized topics like compactly supported wavelets, cardinal splines and spline wavelets.

UNIT I FOURIER ANALYSIS 9

Fourier and inverse Fourier transforms - Continuous time convolution and the delta function - Fourier transform of square integrable functions - Poisson's summation formula.

UNIT II WAVELET TRANSFORMS AND TIME - FREQUENCY ANALYSIS 9

The Gabor transform - Short time Fourier transforms and the uncertainty principle - The integral wavelet transform - Diadic Wavelets and inversions - Frames.

UNIT III MULTI RESOLUTION ANALYSIS AND WAVELETS 11

The Haar wavelet construction - Multi resolution analysis - Riesz basis to orthonormal basis - Sealing function and scaling identity - Construction of wavelet basis.

UNIT IV COMPACTLY SUPPORTED WAVELETS 10

Vanishing moments property - Meyer's wavelets - Construction of a compactly supported wavelet - Smooth wavelets.

UNIT V CARDINAL SPLINES AND SPLINE WAVELETS 6

Cardinal spline spaces-B-splines-computation of cardinal splines-spline wavelets - Exponential decay of spline wavelets.

TOTAL: 45 PERIODS

OUTCOME

- Students would be trained to handle "Wavelets", which is a versatile tool with rich mathematical content and has great potential for applications in engineering.

TEXTBOOK

1. Chui C.K., "An introduction to Wavelets", Academic Press, San Diego, CA, 1992.

REFERENCES

1. Wojtaszczyk P., "A mathematical introduction to Wavelets", London Mathematical Society Student Texts 37, Cambridge University Press, 1997.
2. Chan Y.T., "Wavelet Basics", Kluwer Academic Publishers,1995.