THAPAR UNIVERSITY

COURSES SCHEME

&

SYLLABUS

FOR

M.SC.

MATHEMATICS & COMPUTING

2015

SCHOOL OF MATHEMATICS

Name of Programme: Master of Science (Mathematics and Computing)

Nature: Full time/ Part time/ Correspondence: Full Time

Duration: Two Years (4 Semesters)

Eligibility Criteria and Admission Procedure: Minimum 60% (55% for SC/ST) at graduation level with Mathematics as main subject. Admissions shall be made by merit which will be made by combining percentage of marks obtained at 10th, 12th and graduation (aggregate marks upto second year/four semesters will be considered). Graduation must be done from a recognized University.

Number of Seats: 20

Objective of the program: The objectives of the M.Sc. (Mathematics and Computing) program are to develop students with the following capabilities:

1. To provide students with a knowledge, abilities and insight in Mathematics and computational techniques so that they are able to work as mathematical professional.
2. To provide students with advanced mathematical and computational skills that prepares them to pursue higher studies and conduct research.
3. To train students to deal with the problems faced by software industry through knowledge of mathematics and scientific computational techniques.
4. To provide students with knowledge and capability in formulating and analysis of mathematical models of real life applications.
5. To increase student's self-confidence in conducting research independently or within a team.

Outcome of the program: The successful completion of this program will enable the students to:

1. Demonstrate the ability to conduct research independently and pursue higher studies towards the Ph.D. degree in mathematics and computing.
2. Carry out development work as well as take up challenges in the emerging areas of Industry.
3. Demonstrate competence in using mathematical and computational skills to model, formulate and solve real life applications.
4. Acquire deep knowledge of different mathematical and computational disciplines so that they can qualify NET/ GATE examination.

COURSE SCHEME & SYLLABUS FOR

M.SC. (MATHEMATICS AND COMPUTING)

SEMESTER – I

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PMC107	REAL ANALYSIS – I	3	1	0	3.5
2	PMC108	ALGEBRA-I	3	1	0	3.5
3	PHU002	PROFESSIONAL COMMUNICATION	3	1	0	3.5
4	PMC104	FUNDAMENTALS OF COMPUTER SCIENCE AND C PROGRAMMING	3	0	4	5.0
5	PMC105	DISCRETE MATHEMATICAL STRUCTURE	3	1	0	3.5
6	PMC106	DIFFERENTIAL EQUATIONS	3	1	0	3.5
TOTAL			**18**	**5**	**4**	**22.5**

SEMESTER – II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PMC201	REAL ANALYSIS –II	3	1	0	3.5
2	PMC205	DATA BASE MANAGEMENT SYSTEM	3	0	2	4.0
3	PMC209	NUMERICAL ANALYSIS	3	1	2	4.5
4	PMC210	DATA STRUCTURES AND ALGORITHMS	3	0	4	5.0
5	PMC103	COMPLEX ANALYSIS	3	1	0	3.5
6	PMC211	COMPUTER ORGANIZATION AND OPERATING SYSTEMS	3	0	2	4.0
TOTAL			**18**	**3**	**10**	**24.5**

SEMESTER – III

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PMC305	MATHEMATICAL METHODS	3	1	0	3.5
2	PMC306	PROBABILITY AND STATISTICS	3	1	2	4.5
3	PMC303	COMPUTER NETWORKS	3	0	2	4.0
4	PMC304	MECHANICS	3	1	0	3.5
5	PMC208	OPERATIONS RESEARCH	3	1	2	4.5
6	PMC391	SEMINAR	-	-	-	2.0
7		ELECTIVE-I	3	0	2	4.0
TOTAL			**18**	**4**	**8**	**26.0**

SEMESTER – IV

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PMC401	FUNCTIONAL ANALYSIS	3	0	0	3.0
2	PMC402	ALGEBRA-II	3	1	0	3.5
3		ELECTIVE-II	3	0	0	3.0
4	PMC491	DISSERTATION	-	-	-	6.0
TOTAL			**9**	**1**	**0**	**15.5**

TOTAL CREDITS: 88.5

ELECTIVE- I

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PMC311	COMPUTER GRAPHICS	3	0	2	4.0
2	PMC312	OBJECT ORIENTED PROGRAMMING	3	0	2	4.0
3	PMC313	GRAPH THEORY AND APPLICATIONS	3	0	2	4.0
4	PMC314	ARTIFICIAL NEURAL NETWORKS	3	0	2	4.0
5	PMC315	DIGITAL IMAGE PROCESSING	3	0	2	4.0
6	PMC317	SOFTWARE ENGINEERING	3	0	2	4.0
7	PMC318	DESIGN AND ANALYSIS OF ALGORITHMS	3	0	2	4.0
8	PMC319	WAVELETS AND APPLICATIONS	3	0	2	4.0
9	PMC323	THEORY OF COMPUTATION	3	0	2	4.0
10	PMC324	WIRELESS NETWORKS AND MOBILE COMPUTING	3	0	2	4.0
11	PMC325	INFORMATION AND NETWORK SECURITY	3	0	2	4.0

ELECTIVE –II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PMC411	NUMERICAL METHODS FOR PARTIAL DIFFERENTIAL EQUATIONS	3	0	0	3.0
2	PMC422	FLUID MECHANICS	3	0	0	3.0
3	PMC423	ALGEBRAIC CODING THEORY	3	0	0	3.0
4	PMC424	FINITE ELEMENT METHODS	3	0	0	3.0
5	PMC301	TOPOLOGY	3	0	0	3.0
6	PMC426	NUMBER THEORY AND CRYPTOGRAPHY	3	0	0	3.0
7	PMC427	FUZZY SETS AND APPLICATIONS	3	0	0	3.0
8	PMC432	ADVANCED OPERATIONS RESEARCH	3	0	0	3.0
9	PMC433	THEORY OF ELASTICITY	3	0	0	3.0
10	PMC430	MODELING OF STELLAR STRUCTURE	3	0	0	3.0

PMC107: REAL ANALYSIS – I

L	T	P	Cr
3	1	0	3.5

Course Objectives: This course presents a rigorous treatment of fundamental concepts in analysis. To introduce students to the fundamentals of mathematical analysis and reading and writing mathematical proofs. The course objective is to understand the axiomatic foundation of the real number system, in particular the notion of completeness and some of its consequences; understand the concepts of limits, continuity, compactness, differentiability, and integrability, rigorously defined; Students should also have attained a basic level of competency in developing their own mathematical arguments and communicating them to others in writing.

Real Number System and Set Theory: Completeness property, Archmedian property, Denseness of rationals and irrationals, Countable and uncountable sets, Cardinality, Zorn's lemma, Axiom of choice.

Metric Spaces: Open and closed sets, Interior, Closure and limit points of a set, Subspaces, Continuous functions on metric spaces, Convergence in a metric space, Complete metric spaces, Compact metric spaces, Compactness and uniform continuity, Connected metric spaces, Totally boundedness, Finite intersection property.

Sequence and Series of Functions: Pointwise and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass M-test, Abel's and dirichlet's tests for uniform convergence, Uniform convergence and continuity, Uniform convergence and differentiation, Weierstrass approximation theorem.

Riemann-Stieltje's Integral: Definition and existence of Riemann-Stieltje's integral, Properties, Integration and differentiation, Fundamental theorem of calculus.

Course Learning Outcomes (CLO):

Upon completion of this course, the student will be able to:

1) Understand basic properties of R, such as its characterization as a complete and ordered field, Archimedean Property, density of Q and R\Q and unaccountability of each interval.
2) Classify and explain open and closed sets, limit points, convergent and Cauchy convergent sequences, complete spaces, compactness, connectedness, and uniform continuity etc. in a metric space.
3) Know how completeness, continuity and other notions are generalized from the real line to metric spaces.
4) Recognize the difference between pointwise and uniform convergence of a sequence of functions.
5) Illustrate the effect of uniform convergence on the limit function with respect to continuity, differentiability and integrability.
6) Determine the Riemann-Stieltjes integrability of a bonded function and prove a selection of theorems and concerning integration.

Recommended Books:

1. *Rudin, W., Principles of Mathematical Analysis, McGraw-Hill (2013).*
2. *Simmons G. F., Introduction to Topology and Modern Analysis, Tata McGraw Hill (2008).*
3. *Malik, S.C. and Arora, S., Mathematical Analysis, Wiley Eastern (2010).*
4. *Jain, P. K., Ahmad Khalil, Metric Spaces, Alpha Science Publishers (2004).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	25

PMC108: ALGEBRA – I

L	T	P	Cr
3	**1**	**0**	**3.5**

Course Objectives: The objective of the course is to introduce basic structures of algebra like groups, rings, fields and vector spaces which are the main pillars of modern mathematics. The course gives the student a good mathematical maturity and enables to build mathematical thinking and skill.

Group Theory: Normaliser, Centralizer, Homomorphism, cyclic groups, Permutation groups, Cayley's theorem, Conjugate elements, Class equation, Structure theory of groups, Cauchy theorem, Sylow theory and its applications.

Ring Theory: Special kinds of rings, Subrings and ideals, homomorphism, Quotient rings, Prime and maximal ideals, Polynomial rings, Integral domain, Factorization theory in integral domains, Unique factorization domain, Principal ideal domain, Euclidean domain.

Course Learning Outcomes (CLO):

Upon completion of this course, the student will be able to:

1) Explore the properties of groups, sub-groups, including symmetric groups, permutation groups, cyclic groups, normal sub-groups and quotient groups.
2) Understand the concepts of homomorphism and isomorphism between groups.
3) Apply class equation and Sylow theorems to solve different problems.
4) Explore the properties of rings, sub-rings, ideals including integral domain, principle ideal domain, Euclidean ring and Euclidean domain.
5) Understand the concepts of homomorphism and isomorphism between rings.

Recommended Books:

1. *Singh, Surjeet and ZameeruddinQazi, Modern Algebra, Vikas Publishing House (2006).*
2. *Herstein, N., Topics in Algebra, Wiley Eastern Ltd., (2005).*
3. *Bhattacharya, P.B., Jain, S.K., and Nagpaul, S.R., Basic Abstract Algebra, Cambridge University Press (1997).*
4. *Luthar, S., and Passi, I.B.S., Algebra (Vol. 1 and 2), Narosa Publishing House (1999).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	25

PHU002: PROFESSIONAL COMMUNICATION

L	T	P	Cr
3	1	0	3.5

Course Objectives: To provide the students with the essential skills required for effective communication and a comprehensive view of business communication and its role in the corporate environment.

Essentials of Communication: Meaning, Definition, process, feedback, emergence of communication as a key concept in the corporate and global world, impact of technological advancements on communication.

Channels of Communication: Formal and Informal: Vertical, horizontal, diagonal, and grapevine.

Methods and Modes of Communication: Verbal and nonverbal, Verbal Communication: Characteristics of verbal communication, Non-verbal Communication: Characteristics of non-verbal communication, kinesics, proxemics and chronemics.

Barriers to Communication: Physical, semantic, language, socio-cultural, psychological barriers, Ways to overcome these barriers.

Listening: Importance of listening skills, cultivating good listening skills.

Written Communication: Business letters, memos, minutes of meeting, notices, e-mails, agendas and circulars.

Technical Report Writing: Types of Reports, contents of reports. Formatting, writing styles and documentation.

Presentations: Principles of effective presentation, power-point presentation, video and satellite conferencing.

Interviews and Group Activities: Personal interviews, group discussion and panel discussion

Creative writing: Paragraph and Essay writing, Book reviews, Movie Reviews, Editorials and articles.

Paper Writing: Styles of paper writing: Short Communication, Review papers and Research papers, Referencing styles: MLA, Chicago Style and APA.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) Understand and demonstrate the use proper writing techniques relevant to the present day technological demands, including anticipating audience reaction,
2) Write effective and concise letters and memos,
3) Prepare informal and formal reports,
4) Proofread and edit copies of business correspondence
5) Develop interpersonal skills that contribute to effective personal, social and professional relationships

Recommended Books:

1. *Lehman C.M., DuFrene D.D., & Walker R.B-BCOM-An Innovative Approach to Learning and Teaching Business Communication .Cengage Learning New Delhi*
2. *McMurrey A.M & Buckley J., Handbook for Technical Writing. Cengage Learning, New Delhi*
3. *Lesikar R.V &Flately M.E., Basic Business Communication-Skills for Empowering the Internet Generation. Tata McGraw-Hill Publishing Company Limited. New Delhi.*

Evaluation Scheme:

Sr. No.	**Evaluation Elements**	**Weightage (%)**
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	25

PMC104: FUNDAMENTALS OF COMPUTER SCIENCE AND C PROGRAMMING

L	T	P	Cr
3	0	4	5.0

Course Objectives: The aim of this course is to provide adequate knowledge of fundamentals of computer along with problem solving techniques using C programming. This course provides the knowledge of writing modular, efficient and readable C programs. Students also learn the utilization of arrays, structures, functions, pointers and implement these concepts in memory management. This course also teaches the use of functions and file systems.

General Concepts: Introduction to basic computer architecture, Categories of software – System software, Application software, Compiler, Interpreter, Utility program, Operating System and its significance. Binary arithmetic for integer and fractional numbers.

C Programming: Introduction to algorithm, Flow charts, Problem solving methods, C character set, Identifiers and keywords, Data types, Declarations, Statement and symbolic constants, Input-output statements, Preprocessor commands, Operators, expressions and library functions, decision making and loop control statements, Functions, Storage Classes, Arrays, Strings, Pointers, Structure and union, File handling.

Laboratory Work:
Laboratory experiments will be set in consonance with the materials covered in theory.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) Recognize and understand the purpose of basic computer components
2) Implement of simple ‘C’ origram, data types and operators and console I/O function
3) understand decision control statements, loop control statements and case control structures.
4) understand the declaration and implementation of arrays, pointers, functions and structures.
5) To understand the file operations, character I/O, String I/O, file pointers and importance of pre-processor directives.

Recommended Books:

1. *Norton, P., Introduction to Computers, Tata McGraw Hill (2008).*
2. *Shelly, G.B., Cashman T.J., Vermaat M.E., Introduction to Computers, Cengage India Pvt Ltd (2008).*
3. *Kerninghan, B. W. and Ritchie D.M., The C Programming Language, PHI (1989)*
4. *Kanetkar, Y., Let Us C, BPB (2007).*
5. *Forouzan, A., Structured Programming Approach Using C, Cengage India Pvt Ltd (2008).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	35

PMC105: DISCRETE MATHEMATICAL STRUCTURES

L	T	P	Cr
3	1	0	3.5

Course Objectives: Prepare students to develop mathematical foundations to understand and create mathematical arguments, require in learning many mathematics and computer sciences courses. To motivate students how to solve practical problems using discrete mathematics

Mathematical Logic: Statement and notations, Connectives, Statement formulas and truth table, Conditional and bi-conditional statements, Tautology and contradiction, Equivalence of formulas, Tautological implications.

Theory of Inference: Validity using truth table, Rules of inference, Consistency of premises and indirect method of proof, Predicates, Statement function, Variables, Quantifiers, Free and bound variables, Universe of discourse, Inference of the predicate calculus.

Relation: Review of binary relations, equivalence relations, Compatibility relation, Composition of binary relations, Composition of binary relations and transitive closure, Partial ordering and partial ordered set.

Function: Review of functions and their enumeration, Pigeonhole principle.

Recurrence Relation: Iteration, Sequence and discrete functions, Recurrence relations, Generating function.

Lattice and Boolean Algebra: Lattice and algebraic system, Basic properties of algebraic systems, Special types of lattices, Distributed, Complemented lattices, Boolean algebra, Boolean expressions, Normal form of Boolean expressions, Boolean function and its applications to LOGIC GATES.

Course Learning Outcomes (CLO):

Upon completion of this course, the student will be able to:

1) construct mathematical arguments using logical connectives and quantifiers.
2) validate the correctness of an argument using statement and predicate calculus.
3) understand how lattices and Boolean algebra are used as tools and mathematical models in the study of networks.
4) learn how to work with some of the discrete structures which include sets, relations, functions, graphs and recurrence relation.

Recommended Books:

1. *Tremblay, J.P., and Manohar, R., A First Course in Discrete Structures with Applications to Computer Science, McGraw Hill, (1987).*
2. *Kenneth, H. Rosen, Discrete Mathematics and its Applications, WCB/ McGraw Hill.*
3. *Liu, C.L., Elements of Discrete Mathematics, McGraw Hill, New York, (1978).*
4. *Grimaldi, R.P. and Ramana, B.V., Discrete and Combinatorial Mathematics – An Applied Introduction, Pearson education (2004).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	25

PMC106: DIFFERENTIAL EQUATIONS

L	T	P	Cr
3	1	0	3.5

Course Objectives: The main aim of this course is to understand various analytical methods to find exact solution of ordinary and partial differential equations and their implementation to solve real life problems.

Introduction to ODE's: Review of fundamentals of ODEs, Applications of differential equations to vibrations of mass in a spring, Free undamped motion, Free damped motion, Forced motion, Resonance phenomenon and electric circuit problems, Existence and uniqueness theorems.

Solution in Series: Review of power series solutions, Bessel and Legendre differential equations, Gauss's hypergeometric and Chebyshev's differential equations, The generating functions and recurrence relations.

Stability Analysis: Eigen value problems and Sturm-Liouville problem, Stability of linear and nonlinear systems

Partial Differential Equations: First-order linear and quasi-linear PDE's, method of Lagrange's, Cauchy problem, Complete integrals of non-linear equations of first order, Four standard forms, Charpits' method, Linear equations with constant coefficients, Classification of PDE, Solution of hyperbolic, Parabolic and elliptic equations, Dirichlet and Neumann problems.

Minor Projects: The students will develop various types of differential equations representing the mathematical models of physical phenomena such as vibrations of mass on a spring with free undamped motion, free damped motion, forced motion, resonance phenomenon, electric circuit problems, heat and wave equation and will also carry out relevant qualitative study.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) Learn how the differential equations are used to study various physical problems such as mass attached to spring and electric circuit problem etc.
2) Obtain power series solutions of several important classes of ordinary differential equations including Bessel's, Legendre, Gauss's hypergeometric and Chebyshev's differential equations.
3) Understand the Sturm-Liouville problem and analyze stability of linear and non-linear systems.
4) Solve the first-order linear and non-linear PDE's by using Lagrange's and Charpit's methods respectively.
5) Determine the solutions of linear PDE's of second and higher order with constant coefficients.
6) Classify second order PDE and solve standard PDE using separation of variable method.

Recommended Books:

1. *Simmons, G.F., Differential Equations with Applications and Historical Notes, Tata McGraw Hill (1991).*
2. *Ross, S.L., Differential Equations, John Wiley and Sons (2004).*
3. *Sneddon, I.N., Elements of Partial Differential Equations, Tata McGraw Hill (1957).*

4. *Coddington, E.A., and Levinson N., Theory of Ordinary Differential Equations, Tata McGraw Hill (2007).*
5. *Piaggio, H.T.H., Differential Equations, CBS Publisher (2004).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	25

PMC201: REAL ANALYSIS – II

L	T	P	Cr
3	1	0	3.5

Course Objectives: This course provides the essential foundations of important aspect of mathematical analysis. Measure theory and theory of the integral have numerous applications in other branches of pure and applied mathematics, for example in the theory of (partial) differential equations, functional analysis and fractal geometry. The objective of this course is to give mathematical foundation to probability theory and statistics, and on the real line it gives a natural extension of the Riemann integral which allows for better understanding of the fundamental relations between differentiation and integration.

Lebesgue Measure: Introduction, Outer measure, Lebesgue measure measurable sets, Properties of measurable sets, Borel sets and their measurability, Non-measurable sets.

Measurable Functions: Definition and properties of measurable functions, Step functions, Characteristic functions, Simple functions Littlewood's three principles,

Lebesgue Integral: Lebesgue integral of bounded function, Integration of non-negative functions, General Lebesgue integrals, Integration of series, Comparison of Riemann and Lebesgue integrals.

Differentiation and Integration: Differentiation of monotone functions, Functions of bounded variation, Lebesgue differentiation theorem, Differentiation of an integral, Absolute Continuity, Convergence in measure.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) understand how Lebesgue measure on R is defined,
2) understand basic properties are measurable functions,
3) understand how measures may be used to construct integrals,
4) know the basic convergence theorems for the Lebesgue integral,
5) understand the relation between differentiation and Lebesgue integration.

Recommended Books:

1. *Royden, H.L. & P. M. Fitzpatrick, Real Analysis, Pearson Education (2011).*
2. *Barra, G.de, Measure Theory and Integration, Wiley Eastern Ltd. (2012).*
3. *Jain, P.K., and Gupta, V.P., Lebesgue Measure and Integration, New Age International Ltd. (2010).*
4. *Rana, I.K., An Introduction to Measure and Integration, Narosa Publication House (2010).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	25

PMC205: DATA BASE MANAGEMENT SYSTEM

L	T	P	Cr
3	0	2	4.0

Course Objectives: The major objective of this course is to provide a strong formal foundation in database concepts, technology and to give an introduction to systematic database design approaches covering conceptual design, logical design and an overview of physical design. This course will also introduce the concepts of transactions and transaction processing to present the issues and techniques relating to concurrency and recovery. The overriding concern, is present the concepts and techniques by SQL engine and PL/SQL programming.

Introduction: Basic concepts, Database and database users, Characteristics of the database, Database systems concepts and architecture, Data models, Schemas and instances, DBMS architecture and data independence, Database languages and interfaces.

Data Modeling: ER model concepts, Notation for ER diagram, Mapping constraints, Concepts of primary key, Candidate key, Foreign key and super key.

Relational Model, Languages and Systems: Relational data model and relational algebra, Relational model concepts, Relational model constraints, Relational calculus: Tuple and domain calculus.

SQL: SQL data types. Data definition in SQL, View, Queries and sub queries in SQL, Specifying constraints and indexes in SQL, Cursors, Triggers, Procedures and packages in PL/SQL.

Relational Data Base Design: Function Dependencies and normalization for relational databases, Normal forms: INF, 2NF, 3NF, and BCNF, Loss less join and dependency preserving decomposition.

Concurrency Control and Recovery Techniques: Concurrency control techniques, locking techniques, Time stamping protocols for concurrency control, Multiple granularity of data items, Recovery techniques, Database backup and recovery.

Laboratory Work:
Laboratory exercises should include defining schema for applications, creation of a database, writing SQL and PL/SQL queries for database operations.

Minor Projects: The minor projects will be set in consonance with material covered in theory and laboratory classes.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) Understand, appreciate and effectively explain the underlying concepts of database technologies.
2) Design and implement a database schema for a given problem-domain.
3) Populate and query a database using SQL DML/DDL commands.
4) Programming PL/SQL including stored procedures, stored functions, cursors, packages.

Recommended Books:

1. *Date, C. J., An Introduction to Database Systems, Narosa Publishing House (2002)*
2. *Korth, Silbertz, Sudarshan, Database System Concepts, Tata McGraw Hill (2005).*
3. *Desai, B., An Introduction to Database Concepts, Galgotia Publication (2002).*
4. *Elmsari, R. and Navathe, S. B., Fundamentals of Database Systems, Pearson Education (2009).*
5. *Bayross, E., SQL PL/SQL The Programming Language of Oracle, BPB Publication, (2010).*

Evaluation Scheme:

Sr. No.	**Evaluation Elements**	**Weightage (%)**
1	MST	25
2	EST	40
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	35

PMC209: NUMERICAL ANALYSIS

L	T	P	Cr
3	1	2	4.5

Course Objectives: The course is intended as a basic course in numerical analysis. The objective of the course is to familiarize the students about different numerical techniques e.g. solving algebraic and transcendental equations, large linear system of equations, differential equations, approximating functions by polynomials upto a given desired accuracy, finding approximate value of definite integrals of functions etc. The course also throws light on the convergence analysis of these techniques and explains different types of errors which gets involved and propagates during numerical computations.

Error Analysis: Definition and sources of errors, Propagation of errors, Sensitivity and conditioning, Stability and accuracy, Floating-point arithmetic and rounding errors.

Nonlinear Equations: Bisection method, Newton's method and its variants, Fixed point iterations, Convergence analysis with order of convergence, Polynomial equation, Numerical methods for system of non-linear equations.

Linear Systems and Eigen-Values: Gauss-elimination method (using pivoting strategies), Triangularisation method, Gauss-Seidel and SOR methods and their convergence, Rayleigh's power and Jacobi's method for eigen-values and eigen-vectors.

Interpolation and Approximation: Finite differences, Polynomial interpolation, Spline interpolation, Least square polynomial approximation.

Numerical Integration: Trapezoidal and Simpson's rules, Newton-Cotes formula, Gaussian quadrature with error analysis.

Numerical Solution of Differential Equations: Taylor series method, Euler and modified Euler methods, Runge-Kutta methods, Adams-Bashforth, Adams-Moulton and milne's methods, Convergence and stability analysis, BVP: Finite difference method.

Laboratory Work:
Laboratory experiments will be set in consonance with the materials covered in theory.

Minor Projects: The minor projects will be set in consonance with material covered in theory and laboratory classes.

Course Learning Outcomes (CLO):
Upon completion of the course, the students should be able to

1) Understand the errors, source of error and its effect on any numerical computations and also analysis the efficiency of any numerical algorithms.
2) learn how to obtain numerical solution of nonlinear equations using bisection, secant, Newton and fixed-point iterations methods and convergence analysis of these methods.
3) solve linear and nonlinear systems of equations numerically.
4) apply numerical methods to find eigen value and eigen vectors.
5) handle the functions and data set using interpolation and least square curves.
6) Evaluate the integrals numerically.
7) Learn how to solve initial and boundary value problems numerically.

Recommended Books:

1. *Gerald, C.F., and Wheatley P.O., Applied Numerical Analysis, Addison Wesley (2003).*
2. *Atkinson, K. E. and W. Han, Elementary Numerical Analysis, John Wiley & sons (2004).*
3. *Jain, M.K., Iyengar, S.R.K., and Jain, R.K., Numerical Methods for Scientific and Engineering Computation, New Age International Publisher (2012).*
4. *Burden R. L. and Faires J. D., Numerical Analysis, Brooks Cole, 2004*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	40

PMC210: DATA STRUCTURES AND ALGORITHMS

L	T	P	Cr
3	0	4	5.0

Course Objectives: This course shall help the students in understanding how to analyze a given algorithm. This course will also help them in making the choice of data structures and methods to design algorithms that affect the performance of programs. They will also learn to solve problems using data structures such as linear lists, stacks, queues, etc. and shall be writing programs for these structures.

Introduction: Need and definition of data structures, Asymptotic notations, Recursion and recursive functions.

Fundamental Data Structures: Arrays, Stacks, Queues, Linked lists and trees.

Searching and Sorting: Linear search, Binary search, Insertion-sort, Bubble-sort, Selection-sort, Merge sort, Heap sort, Priority queue, Quick sort, Sorting in linear time, Hash tables, Binary search tree.

Graphs: Elementary graph algorithms, Minimum spanning tree, Shortest path algorithms.

Algorithm Design Techniques: Divide and conquer, Greedy algorithm.

Laboratory Work:
Laboratory exercises will be set in consonance with the material covered in lectures. This will include assignments in a programming language like C and C++ in GNU Linux environment.

Minor Project: The minor projects will be set in consonance with material covered in theory and laboratory classes.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) Analyze a given algorithm for its complexity.
2) Appreciate the role of data structures in different implementations.
3) Implement algorithm design techniques to different problems

Recommended Books:

1. *Cormen, T. H., Leiserson, C. E., Rivest, R. L. and Stein, C., Introduction to Algorithms, Prentice-Hall of India, (2007).*
2. *Goodrich, M. T. and Tamassia, R., Data Structures and Algorithms in Java, Wiley, (2006).*
3. *Aho, A. V. and Hopcroft, J. E., Data Structures and Algorithms, Addison-Wesley, (1983).*
4. *Sahni, S., Data Structures, Algorithms and Applications in C++, Universities Press, (2005).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	35

PMC103: COMPLEX ANALYSIS

L	T	P	Cr
3	1	0	3.5

Course Objectives: This course is aimed to provide an introduction to the theories for functions of a complex variable. It begins with the exploration of the algebraic, geometric and topological structures of the complex number field. The concepts of analyticity, Cauchy-Riemann relations and harmonic functions are then introduced. Students will be equipped with the understanding of the fundamental concepts of complex variable theory. In particular, students will acquire the skill of contour integration to evaluate complicated real integrals via residue calculus.

Analytic Functions: Review of complex numbers and its geometry, Function of a complex variable, Mapping, Limits, Continuity, Derivatives, Cauchy Riemann equations, sufficient conditions, Analytic functions, Harmonic functions.

Elementary Functions: Review of Exponential and Trigonometric functions. Logarithmic function and its branches, Inverse trigonometric and hyperbolic functions.

Complex Integration and Series: Cauchy's integral theorem, Cauchy integral formula, Higher derivative, Removable singularities, Morera theorem, Liouville theorem, Maximum-Modulus principle, Schwarz lemma, Power series, Taylor and Laurent series, General form of Cauchy's theorem. Cauchy residue theorem, Zeros and poles, Evaluation of definite integrals using residue theorem, Weierstrass theorem, Residue at infinity.

Conformal Mapping: Elementary conformal maps, Bilinear transformation, Analytic continuation, Method of analytic continuation by power series.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) represent complex numbers algebraically and geometrically,
2) define and analyze limits and continuity for functions of complex variables,
3) understand about the Cauchy-Riemann equations, analytic functions, entire functions including the fundamental theorem of algebra,
4) evaluate complex contour integrals and apply the Cauchy integral theorem in its various versions, and the Cauchy integral formula,
5) analyze sequences and series of analytic functions and types of convergence,
6) represent functions as Taylor and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem'
7) understand the conformal mapping.

Recommended Books:

1. *Churchill, R.V. and Brown J.W., Complex Variable and Applications, Tata McGraw Hill (2008).*
2. *Ahlfors, L.V., Complex Analysis, Tata McGraw Hill (1979).*
3. *Ponnuswamy, S., Foundation of Complex Analysis, Narosa Publishing House (2007).*
4. *Kasana, H.S., Complex Variables: Theory and Applications, PHI (2006).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes/Lab Evaluation)	25

PMC211: COMPUTER ORGANIZATION AND OPERATING SYSTEMS

L	T	P	Cr
3	0	2	4.0

Course Objectives: The course aims to shape the attitudes of learners regarding the field of computer organization as well as operating system. Specifically, the course aim to i) Have the insight of computer organizations and the working of operating systems ii) Instill the belief that computer organization as well as operating is important for IT professional.

Introduction: Computer organization, operating system, Types of operating systems, Register transfer language, Overview of data representation in computer, Instruction, Instruction codes, Instruction types, Instruction set completeness, Instruction cycle, Execution cycle, Addressing modes, Control unit: Micro programmed control Vs hardwired control, RISC Vs CISC.

Input Output Organization: Input and output interface, Asynchronous data transfer, Modes of transfer, DMA, I/O interrupts, Channels.

Process management: Processor scheduling, Schedulers, CPU scheduling algorithms, Concurrent process: Introduction to conflicts due to concurrency, Critical section problem, Deadlock: Introduction to deadlock prevention and avoidance, Detection and recovery.

Memory Management: Memory hierarchy, Associative memory, Demand paging-virtual memory and Segmentation, File Management: File system structure, Allocation methods, Secondary storage management - disk scheduling.

Laboratory Work:
Implementation of CPU scheduling algorithms, process management, memory management and file management functions of Linux/Unix operating systems.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) understand, appreciate and effectively explain the underlying concepts of computer organization.
2) have the idea about instruction set, instruction cycle, RISC as well as CISC.
3) know the process management, scheduling and deadlock.
4) understand the memory management, and file system.

Recommended Books:

1. *Mano Morris, Computer System Architecture, Pearson Education (2007).*
2. *Galvin and Silverscatz, Operating systems concepts, Addison Wesley (2012).*
3. *Patterson, D. A., Computer Architecture – A Quantitative Approach, Morgan Kaufmann Publishers (2011).*
4. *Stallings, W., Computer Organization and Architecture, PHI (2012).*
5. *Dhamdhere, Operating Systems, A Concept-Based Approach, Tata McGraw Hill (2003).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes/Lab Evaluation)	35

PMC305: MATHEMATICAL METHODS

L	T	P	Cr
3	1	0	3.5

Course Objectives: This course is intended to prepare the student with mathematical tools and techniques that are required in advanced courses offered in the applied mathematics and engineering programs. The objective of this course is to enable students to apply transforms and variation problem technique for solving differential equations and extremum problems.

Laplace Transform: Review of Laplace transform, Applications of Laplace transform in initial and boundary value problems, Heat equation, Wave equation, Laplace equation.

Fourier Series and Transforms: Definition, Properties, Fourier integral theorem, Convolution theorem and Inversion theorem, Discrete fourier transforms (DFT), Relationship of FT and fast fourier transforms (FFT), Linearity, Symmetry, Time and frequency shifting, Convolution and correlation of DFT. Applications of FT to heat conduction, Vibrations and potential problems, Z-transform.

Hankel Transform: Hankel transforms, Inversion formula for the Hankel transform, Infinite Hankel transform, Hankel transform of the derivative of a function, Parseval's theorem, The finite Hankel transforms, Application of Hankel transform in boundary value problems.

Integral Equations: Linear integral equations of the first and second kind of fredholm and volterra type, Conversion of linear ordinary differential equations into integral equations, Solutions by successive substitution and successive approximation, Neumann series and resolvent kernel methods.

Calculus of Variations: The extrema of functionals, the variation of a functional and its properties, Euler equations in one and several independent variables, Field of extremals, Sufficient conditions for the extremum of a functional conditional extremum, Moving boundary value problems, Initial value problems, Ritz method.

Course Learning Outcomes (CLO):

1) Laplace Transformation to solve initial and boundary value problems.;
2) To learn Fourier transformation and Z transformation and their applications to relevant problems.;
3) To understand Hankel's Transformation to solve boundary value problem.;
4) Find solutions of linear integral equations of first and second type (Volterra and Fredhlom)
5) Understand theory of calculus of variations to solve initial and boundary value problems.

Recommended Books:

1. *Simmons G.F., Differential Equations with Applications and Historical Notes, Tata McGraw Hill, (1991)*
2. *GelfandI.M. and FominS.V., Calculus of Variations, Prentice Hall (1963).*
3. *Kenwal Ram P., Linear Integral Equations: Theory and Techniques, Academic Press (1971).*
4. *Sneddon I.N.,The Use of Integral Transforms, Tata McGraw Hill (1985).*
5. *Churchill, R.V., Operational Mathematics, McGraw-Hill (1971)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes/Lab Evaluation)	25

PMC306: PROBABILITY AND STATISTICS

L	T	P	Cr
3	1	2	4.5

Course Objectives: The course aims to shape the attitudes of learners regarding the field of statistics. Specifically, the course aim to i) Motivate in students an intrinsic interest in statistical thinking. ii) Instill the belief that statistics is important for scientific research.

Introduction: Definition of probability through different approaches.

Random Variables: Probability distribution of a random variable, Distribution function, Discrete and continuous random variables, Functions of a random variable.

Mathematical Expectation: Moments, Moment generating functions, Characteristic function.

Study of Special Distributions: Binomial, Poisson, Negative binomial, Geometric, Rectangular, Exponential, Normal, Gamma, Log-normal distributions.

Bi-Variate Probability Distribution: Marginal and conditional distributions, Bi-variate normal distribution.

Limit Theorems: Modes of convergence and their interrelationships; Law of large numbers, Central limit theorem.

Correlation and Regression: Regression between two variables, Karl-Pearson correlation coefficient and rank correlation. Multiple regression, Partial and multiple correlation (three variables case only)

Random Sampling: Sampling distributions chi-square, T and F distributions.

Point Estimation: Probabilities of point estimates, Method of maximum likelihood.

Testing of Hypothesis: Fundamental notions, Neyman-Pearson lemma (without proof), Important tests based on normal, Chi-square, T and F distributions.

Laboratory Work:
Lab work will be based on the programming in C/ C++ language of various statistical techniques. Various statistical aspects are covered in SPSS also.

Minor Projects: The minor projects will be set in consonance with material covered in theory and laboratory classes.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) compute the probabilities of composite events using the basic rules of probability.
2) demonstrate understanding the random variable, expectation, variance and distributions.
3) explain the large sample properties of sample mean.
4) understand the concept of the sampling distribution of a statistic, and in particular describe the behavior of the sample mean
5) analyze the correlated data and fit the linear regression models.
6) demonstrate understanding the estimation of mean and variance and respective one-sample and two-sample hypothesis tests.

Recommended Books:

1. *Meyer P.L., Introduction to Probability and Statistical Applications, Oxford &IBH (2007).*
2. *Goon, A.M., Gupta, M.K. and Dasgupta, B., An Outline of Statistical Theory, Vol. I the World Press Pvt. Ltd. (2000).*
3. *Hogg, R.V., and Craig, A.T., Introduction to Mathematical Statistics, Prentice Hall of India (2004)*
4. *Anderson, T.W., An Introduction to Multivariate Statistical Analysis, John Wiley (2003).*

Evaluation Scheme:

Sr. No.	**Evaluation Elements**	**Weightage (%)**
1	MST	25
2	EST	35
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	40

PMC303: COMPUTER NETWORKS

L	T	P	Cr
3	0	2	4.0

Course Objectives: The course has been intended to impart knowledge in the domain of topology, data communication, protocols and data propagation issues in computer networks. The contents are descriptive to enforce knowledge of working of seven layers of network model, path finding issues, security and other communication paradigm.

Introduction to Computer Networks: Advantages of networks, Type of networks, Network topologies, Protocol hierarchy, OSI reference model, TCP/IP reference model, Comparison of OSI and TCP/IP reference model. Standard organizations, Data rate limits, Digital and analog transmission, Transmission media, Multiplexing and switching Techniques, Network devices.

Data Link Layer: Design issues, Framing, Error control, Flow control, Error correcting codes, Error detecting codes, Sliding Windows protocols, HDLC, Channel allocation problem, Multiple access protocols, Ethernet.

Network Layer: Network layer design issues, Routing algorithms: Shortest path algorithm, flooding, Distance vector routing, Link state routing, Hierarchical routing, Broadcast routing, multicast routing, Congestion control algorithms, Internetworking, IP protocol, IP addressing, Subneting, Superneting, ARP, RARP, BOOTP, DHCP, ICMP, OSPF, BGP, Internet multicasting, Mobile IP, Ipv6.

Transport Layer: Services provided to the upper layer, Addressing, UDP, TCP, Connection establishment, connection release, Flow control and buffering, Multiplexing, TCP congestion control, TCP timer management.

Application Layer: Introduction to Domain name system, E-mail, File transfer protocol, HTTP, HTTPS, World Wide Web.

Laboratory Work:
The lab work will be based on network installation using Windows server and Linux server, implementation of the different application layer protocols on these server, configuration of network devices like switches, routers and implementation of the protocols on these devices. Socket programming using different types of sockets.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) Understand the functions and working of different networking devices
2) Learn topology, data communications, protocol and data propogation issues in computer networks.
3) Know the working of seven-layer network model, TCP/IP, OSI etc.,
4) To understand the different routing algorithms.

Recommended Books:

1. *Forouzan B. A., Data communications and networking, Tata McGraw Hill (2006).*
2. *Tannenbaum A.S., Computer Networks, Pearson Education (2004).*
3. *Stalling, W., Data and Computer Communication, Pearson Education (2003).*
4. *AntonakoJ.L., Mansfield K.C., An Introduction to Computer Networks, Pearson Education (2002).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	35

PMC304: MECHANICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: This course is intended to provide a treatment of basic knowledge in mechanics used in deriving a range of important results and problems related to rigid bodies The objective is to provide the student the classical mechanics approach to solve a mechanical problem.

Dynamics of a Particle: Tangential and normal accelerations, Simple harmonic motion, Oscillatory motion projectile motion, Central forces, Apses and apsidal distances, Stability of orbits, Kepler's laws of planetary motion, Disturbed orbits, Simple pendulum, Motion in a resisting medium, Motion of a pendulum in a resisting medium.

Linear and Angular Momentum: Rate of change of angular momentum for a system of particles, Moving origin, Impulsive forces, Moments and products of inertia of a rigid body, Momental ellipsoid, Equimomental system, Principal axes, Coplanar distribution, General equations of motion.

Motion About a Fixed Axis: Compound pendulum, Centre of percussion, Motion in two dimensions, Euler's dynamical equations and simple stability considerations.

Classical Mechanics: Constrained motion, D'Alemberts principle, Variational Principle, Lagrange's equations of motion, Generalised coordinates, cyclic coordinates, Hamilton's principles, Principles of least action, Hamilton's equation of motion, Lagendre transformation, Phase, Space, State space examples, Cannonical transformations, Contact transformation, Lagrange's and Poisson brackets invariance, Hamilton-Jacobi Poisson equations.

Course Learning Outcomes (CLO):

Upon completion of this course, the student will be able to:

1) Understand the dynamics involving a single particle like projectile motion, Simple harmonic motion, pendulum motion and related problems.
2) Study the path described by the particle moving under the influence of central force.
3) Apply the concept of system of particle in finding moment inertia, directions of principle axes and consequently Euler's dynamical equations for studying rigid body motions.
4) Represent the equation of motion for mechanical systems using the Lagrangian and Hamiltonian formulations of classical mechanics.
5) Obtain canonical equations using different combinations of generating functions and subsequently developing Hamilton Jacobi method to solve equations of motion.

Recommended Books:

1. *Chorlton F., Text book of Dynamics, CBS Publishers (1985).*
2. *Synge, J.L., and Griffith, B.A., Principles of Mechanics, Tata McGraw Hill (1971).*
3. *Fox C., An Introduction to the Calculus of Variations, Dover Publications (1992).*
4. *Goldstein H., Poole C., and Safko J., Classical Mechanics, Addison Wesley (2002).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes/Lab Evaluation)	25

PMC208: OPERATIONS RESEARCH

	L	T	P	Cr
	3	**1**	**2**	**4.5**

Course Objectives: Operations research helps in solving problems in different environments that needs decisions. This module aims to introduce students to use quantitative methods and techniques for effective decisions–making; model formulation and applications that are used in solving business decision problems.

Linear Programming: Formulation of linear programming problem (LPP) -graphical method, Simplex method, Theory of simplex method, Revised simplex method, Duality theory for LPP, Dual simplex method, Sensitivity analysis and parametric linear programming.

Integer Programming: Gomory's cutting plane algorithm, Branch and bound technique.

Transportation and Assignment Problem: Initial basic feasible solutions of balanced and unbalanced assignment/transportation problems, Optimal solutions. Time minimization assignment/transportation problem.

Game Theory: Two-person zero-sum game, Game with mixed strategies, Dominance property, solution by linear programming.

Network Analysis: Project management with CPM and PERT.

Nonlinear Programming: Concept of convexity and concavity, Maxima and minima of convex functions, unconstrained problems, constrained programming problems, Kuhn-Tucker conditions for constrained programming problems.

Laboratory Work:
Laboratory experiments will be set in consonance with the materials covered in theory.

Minor Project: The students will get awareness about the real world problems, their understanding and ability to formulate mathematical models of these problems. For example: Finance, Budgeting, Investment, Agriculturist, Transportation, Cable network, Traveling salesman and many more such problems.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:

1. formulate some real life problems into Linear programming problem.
2. use the simplex method to find an optimal vector for the standard linear programming problem and the corresponding dual problem
3. prove the optimality condition for feasible vectors for Linear programming problem and Dual Linear programming problem.
4. find optimal solution of transportation problem and assignment problem
5. learn the constructions of networks of a project and optimal scheduling using CPM and PERT.
6. formulate and solution of linear programming model of two person zero sum game
7. solve nonlinear programming problems using Lagrange multiplier and using Kuhn-Tucker conditions

Recommended Books:

1. *Taha, H. A., Operations Research- An Introduction, PHI (2007).*
2. *Bazaraa, M.S., Jarvis, J.J., and Sherali, H.D., Linear Programming and Network flows, John Wiley and Sons (1990).*

3. *Bazaraa, M.S., Sherali, H.D., Shetty, C.M., Nonlinear Programming: Theory and Algorithms, John Wiley and Sons, (1993).*
4. *Chandra, S., Jayadeva, Mehra, A., Numerical Optimization and Applications, Narosa Publishing House, (2013).*
5. *Sinha, S.M., Mathematical Programming Theory and Methods, Elsevier, (2006).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	40

PMC401: FUNCTIONAL ANALYSIS

L	T	P	Cr
3	0	0	3.0

Course Objectives: The main aimthis course is to provide students basic concepts of functional analysis to facilitate the study of advanced mathematical structures arising in the natural sciences and the engineering sciences and to grasp the newest technical and mathematical literature.

Normed Linear Spaces: Normed linear space, Banach space and examples$(L_1, L_2, L_\infty, L_p \text{ space})$. Quotient spaces, Equivalent norms, bounded linear transformation, Normed linear spaces of bounded linear transformations, Hahn-Banach theorem and its applications, Riesz- Representation theorem, Uniform boundedness principle, Open mapping theorem, Projection on a banach space, Closed graph theorem, Dual spaces with examples.

Hilbert Spaces: Inner product spaces, Hilbert spaces, Orthogonality, Orthonormal sets, Bessel's inequality, Parseval's theorem, Orthogonal complement and projection theorem, Riesz-Representation theorem.

Operators: Adjoint operators, Self-adjoint operators, Positive operators, Normal and Unitary operators, Projection.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) Understand the normed linear spaces, Banach space and Dual spaces
2) Understand inner product spaces, orthogonality and Hillbert spaces.
3) distinguish between finite and infinite dimensional spaces.
4) apply linear operators in the formulation of differential and integral equations.

Recommended Books:

1. *Simmons, G.F., Introduction to Topology and Modern Analysis, Tata McGraw Hill (1963).*
2. *Limaye, B.V., Functional Anaylsis, Wiley Eastern Ltd (2007).*
3. *Kreyszig E., Introductory Functional Analysis with Applications, John Wiley and Sons (1978).*
4. *Conway J.B., A course in Functional Analysis, Springer Verlag (1990).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	50
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	20

PMC402: ALGEBRA - II

L	T	P	Cr
3	**1**	**0**	**3.5**

Course Objectives: The main objective of this course is to encourage students to develop a working knowledge of the central ideas of Linear Algebra like linear transformations, eigenvalues, eigenvectors, canonical forms and Field Theory like field extensions, splitting field and Galois theory.

Field Theory: Characteristic of a field, Subfield and prime field, Extension of fields, Finite and infinite extensions, Algebraic element, Minimal polynomial of an algebraic element, Algebraic and transcendental extensions, Splitting fields, Multiple roots, Separable and inseparable extensions, Finite fields, Galois theory, Monomorphisms and their linear independence, Normal extensions, Fundamental theorem of Galois theory.

Vector Spaces: Vector spaces, Subspaces, Quotient spaces, Linear dependence, Basis, Dimension, Algebra of linear transformations, Matrix representation of linear transformations, Change of basis.

Canonical Forms: Linear transformations and their characteristic roots and vectors, Minimal polynomial of a linear transformation, Geometric and algebraic multiplicity, Singular and non-singular transformations, Minimal polynomial of a vector relative to a linear transformation, Triangular form, Jordan canonical form.

Course Learning Outcomes (CLO):

Upon completion of this course, the student will be able to:

1) Understand the concepts of fields, extension of fields and splitting fields of polynomials.
2) Understand properties of finite fields and Galois theory.
3) Understand the concepts of vector spaces, basis, dimension and linear transformations.
4) Find the metrics corresponding to linear transformation and different canonical forms like triangular and Jordan canonical form etc.

Recommended Books:

1. *Herstein, I.N., Topics in Algebra, Wiley Eastern Ltd. (2005)*
2. *Singh, Surjeet and ZameeruddinQazi, Modern Algebra, Vikas Publishing House, (2006).*
3. *Hoffmann, K. and Kunze R., Linear algebra, PHI, (2011).*
4. *Bhattacharya, P.B., Jain, S.K. and Nagpaul, S.R. Basic Abstract Algebra, Cambridge University Press (1997).*
5. *Luthar, I.S., and Passi, I.B.S., Algebra (Vol. 4), Narosa Publishing House (2004).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	25

PMC311: COMPUTER GRAPHICS

L	T	P	Cr
3	0	2	4.0

Course Objectives: The course develop student's knowledge and understanding in the fundamental principles of computer graphics, hardware system architecture for computer graphics, computer graphic algorithms such as geometric representation, scan conversion; and 2D and 3D objects' viewing and transformation The student will be able to understand the basic mathematical concepts related to computer graphics including linear algebra and geometry, graphics pipeline, frame buffers, and graphic accelerators/co-processors.

Introduction: Applications and importance of computer graphics in different areas; Graphics input devices, Output devices display devices-random scan and raster scan displays.

Graphics Hardware: Video controller, Graphics controller, Raster scan display processor.

Scan Conversion: Scan converting lines, Rectangles, Circles, Ellipses, Arcs and sectors. DDA algorithm. Bresenham Algorithm, Midpoint algorithms for line and circle.

Filling Polygons: Boundary fill, Flood fill, Scan line polygon fill algorithm.

Transformations: 2D transformations, 3D transformations, Homogeneous coordinates and matrix representation, translation, scaling, rotation. Composition of 2D transformations and 3D ransformations.

Viewing Transformations and Clipping: Coordinate conventions: World coordinates, Device coordinates, Normalized device coordinates, Zooming and panning by changing coordinate reference frames Window-to-viewport transformation, clipping Lines-Cohen Sutherland, Clipping Polygons Sutherland Hodgeman algorithm.

Mathematics of Projection: Perspective projection, Parallel projection.

Geometric Forms and Models: Polygon surfaces, Curved surfaces, Parametric equations, Beizer curves, Spline curves, Beizer surfaces, Spline surfaces.

Visible Surface Determination: Algorithms for visible line determination, z-buffer algorithm, list priority algorithm, scan-line algorithm, painter's algorithm, subdivision algorithm.

Illumination and Shading: Illumination models, shading models for polygons.

Laboratory Work:
Laboratory experiments will be set in consonance with the materials covered in theory.

Course Learning Outcomes (CLO):
Upon successful completion of this course, the student will be able to:

1) understand the basic mathematical models and algorithms related to geometric representation scan conversion and object viewing and transformation;
2) understand and recognize essential concepts, principles, theories, current and future development for computer graphics disciplines.
3) develop skill in image rendering using computer graphics technology;
4) develop good understanding of various graphics algorithms and the trend of their use in various real-life systems

Recommended Books:

1. *Hearn D. and Baker P., Computer Graphics, Pearson Education (2004).*
2. *Foley J., Dam A. Van, Feiner S., and Hughes J., Computer Graphics: Principles and Practice, Pearson and Education (1996).*
3. *Rogers D. and Adams J., Mathematical Elements for Computer Graphics, International Student Edition (1989).*
4. *Plastock R. and Kalley G., Theory and Problems of Computer Graphics, Tata McGraw Hill (1986).*

Evaluation Scheme:

Sr. No.	**Evaluation Elements**	**Weightage (%)**
1	MST	25
2	EST	40
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	35

PMC312: OBJECT ORIENTED PROGRAMMING

L	T	P	Cr
3	**0**	**2**	**4.0**

Course Objectives: The main objective of this course is to define and highlight the importance of object oriented programming. The students will see how to use concepts of object oriented programming in real-life using C++ programming language. The students will learn potential C++ features like overloading, type conversions, inheritance and will be beneficial for students and programmers who are stepping in software industries and the world of information technology.

Introduction: Object oriented vs. procedural programming, Object oriented programming Features and benefits, Characteristics of the object oriented approach, Identifying object classes, Class identification.

Classes and Objects: Defining member functions, Members access control, Use of scope resolution operator, making functions inline, Nesting of member functions, Private member functions, Memory allocation for objects, Static data members, Static member functions, Array of objects, Objects as function arguments, Friend functions and friend classes, Returning objects, const member functions.

Constructors and Destructors: Types of constructors- default, parameterized and copy constructors, Dynamic constructors, Multiple constructors in a class. Destructors, Rules for constructors and destructors, Dynamic initialization of objects, new and delete operators.

Operator Overloading and Type Conversions: Overloading unary, binary operators, Operator overloading using friend functions, Rules for overloading operators, Type conversions- Basic to class type, Class to basic type, One class to another class type.

Inheritance: General concepts of Inheritance, Types of derivation-public, private, protected, Types of inheritance: Single, Multilevel, Multiple and Hybrid inheritance, Types of base classes: Direct, indirect, virtual and abstract, Constructors in derived classes, Containership, Polymorphism with pointers, Pointer to objects, this pointer, Pointers to derived classes, Virtual functions, Pure virtual functions.

Files and Streams: Streams, Stream classes for console operations, Unformatted I/O operations, Formatted console I/O operations, managing output with manipulators, File streams, Opening, Reading, Writing to file. File pointers and their manipulators.

Templates and Exception.

Laboratory Work:
Laboratory experiments will be set in context with the materials covered in theory.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:

1) Learn the fundamentals of object oriented programming using C++ programming language.
2) Learn how OOP concepts like data abstraction, information hiding and code reusability are managed efficiently with C++.
3) Evaluate and apply the concepts of inheritance and polymorphism among classes
4) Explain the benefits of object oriented design and the types of systems in which it is an appropriate methodology.

Recommended Books:

1. *Deitel and Deitel, C++ How to Program, Pearson Education (2004).*
2. *Balaguruswamy, E., Objected Oriented Programming with C++, Tata McGraw Hill (2008).*
3. *Schildt Herbert, The Complete Reference C++, Tata McGraw Hill (2003).*
4. *Stephen Prata, C++ Primer Plus, Pearson Education (2002).*
5. *Kanetkar Y. Let US C++, BPB, (1999).*

Evaluation Scheme:

Sr. No.	**Evaluation Elements**	**Weightage (%)**
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes/Lab Evaluation)	35

PMC313: GRAPH THEORY AND APPLICATIONS

L	T	P	Cr
3	**0**	**2**	**4.0**

Course Objectives: The objective of the course is to introduce students with the fundamental concepts in graph Theory, with a sense of some its modern applications. They will be able to use these methods in subsequent courses in the design and analysis of algorithms, computability theory, software engineering, and computer systems.

Preliminaries: Graph, sub-graph and simple graphs, graph isomorphism, matrix representations, operation on graphs, degrees, paths and connection, cycles, directed graphs, directed paths, directed cycles, the shortest path algorithms, Sperner's lemma, chordal graph, A job sequencing problems, Making a road system one-way.

Trees and Networks: Trees, cut edges and bonds, cut vertices, Cayley Formula, the max-flow min-cut theorem, connectivity, blocks. The Connector problem, Menger's theorem.

Planar Graphs: Plane and planar graphs, dual graphs, Euler's formula, bridges, Kuratowski's theorem, The five - colour theorem, Four-colour theorem, non-hamiltonian planar graphs, Planarity algorithm.

Euler Tour and Hamiltonian Cycle: Euler tour, Hamiltonian cycle, Fleury's algorithm, The Chinese postman problem, The traveling salesman problem.

Matching: Matching in Bipartite graphs, perfect matching. The personnel Assignment problems, The Optimal assignment problems.

Colorings: Edge chromatic number, Coloring of Chordal graph, Class-1 graphs, Class-2 graphs, Vizing's theorem, Brook's theorem, Hajos's conjecture, Chromatic polynomials, the time tabling problems.

Laboratory Work:

The laboratory work shall be based upon the implementation of graph theory concepts like paths, circuits, shortest path problems, tree, Euler tour, Hamiltonian cycles, Chinese postman problem, the traveling salesman problem, matching in Bipartite graphs, coloring of graphs.

Course Learning Outcomes (CLO):

Upon completion of the course, the students will be able to:

1) understand the basic concepts of graphs, directed graphs, and weighted graphs and able to present a graph by matrices.
2) understand the properties of trees and able to find a minimal spanning tree for a given weighted graph.
3) understand Eulerian and Hamiltonian graphs.
4) apply shortest path algorithm to solve Chinese Postman Problem.
5) apply the knowledge of graphs to solve the real life problem.

Recommended Books:

1. *Bondy, J. A. and Murty, U.,S.,R., Graph Theory with Applications, North Holland Publication (2000).*
2. *Marshall, C. W., Applied Graph Theory, John Wiley and Sons (1989).*
3. *West, D. B., Introduction to Graph Theory, Pearson Education (2001).*
4. *Diestel, R., Graph Theory, Springer (2000).*
5. *Deo, N., Graph Theory with Application to Engineering with Computer Science, PHI (2004).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	35

PMC314: ARTIFICIAL NEURAL NETWORKS

L	T	P	Cr
3	0	2	4.0

Course Objectives: This course shall help students in understanding the role of neural networks in artificial intelligence and machine learning. Students shall get knowledge on different learning paradigms for neural networks and also on different neural network models.

Introduction: Biological Analogy, Architecture classification, Neural models, Learning paradigm and rule, single unit mapping and the perception.

Concepts in ANN: Feed forward networks – Review of optimization methods, Back propagation, Variation on back propagation, FFANN mapping capability, Mathematical properties of FFANN's Generalization, Bios and variance Dilemma, Radial basis function networks.

Recurrent Networks – Symmetric Hopfield networks and associative memory, Boltzmann machine, Adaptive resonance networks

Other Networks: PCA, SOM, LVQ, Hopfield networks, RBF networks, Applications of artificial neural networks to function Approximation, Regression, Classification, Blind source separation, Time series and forecasting.

Laboratory Work:
The lab work will be based on the implementations of different neural networks strategies using C/C++ (or on MATLAB/MATHEMATICA) on various case studies.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) appreciate the role of neural networks in machine learning process.
2) learn the use of artificial neural networks in real life applications.
3) implement different artificial neural network models.

Recommended Books:

1. *Haykin, S., Neural Networks-A Comprehensive Foundations, Prentice-Hall International (2007).*
2. *Zurada, J.M, Introduction to Artificial Neural Systems, Jaico Publishing House (2006).*
3. *Anderson, J.A., An Introduction to Neural Networks, Prentice Hall of India (2009).*
4. *Freeman, J.A., Skapura, D.M., Neural Networks: Algorithms, Applications and Programming Techniques, Addison-Wesley (1991).*

Evaluation Scheme:

Sr. No.	**Evaluation Elements**	**Weightage (%)**
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes/Lab Evaluation)	35

PMC315: DIGITAL IMAGE PROCESSING

L	T	P	Cr
3	0	2	4.0

Course Objectives: The objective of this course is to cover the basic theory and algorithms that are widely used in digital image processing, expose students to current technologies and issues that are specific to image processing systems and develop critical thinking about shortcomings of the state of the art in image processing.

Introduction and Digital Image Fundamentals: Digital image representation, Fundamental steps in image processing, Elements of digital image processing systems, Sampling and quantization, Neighbors of a pixel, Adjacency, Connectivity, Regions and boundaries, Distance measures, Image operations on a pixel's basis, Linear and nonlinear operations.

Image Enhancement in Spatial domain: Gray level transforms, Histogram processing, Enhancement using arithmetic/logic operations, Smoothing and sharpening filters.

Image Enhancement in Frequency domain: 1-D and 2-D Fourier Transform and their Inverse, Filtering, Smoothing and sharpening domain filters, Homomorphic filtering.

Image Restoration: Degradation model, Noise models, Restoration in the presence of noise only spatial filtering, Periodic noise reduction by frequency domain filtering, Estimating degradation function.

Color Image Processing: Color models, Pseudocolor image processing, Color transforms, Smoothing and sharpening, Color segmentation, Noise in color images, Color image compression.

Image Compression: Fundamentals, Compression models, Error free compression, Lossy compression, Wavelets in image compression, Image compression standards.

Morphological Image Processing: Dilation and erosion, Basic morphological algorithms, Extension to gray scale images.

Image Segmentation: Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region oriented Segmentation. motion based Segmentation.

Representation and Description: Representation schemes, Boundary description, Regional descriptors, Morphology.

Object Recognition: Patterns and pattern classes, Decision theoretic methods, Structural methods.

Laboratory Work:
The programs on image enhancement, image zooming, image cropping, image restoration, image compression, image segmentation will be implemented in MATLAB/Mathematica.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) understand the basic theory and algorithms that are widely used in digital image processing
2) understand the current technologies and issues that are specific to image processing systems.
3) develop image processing algorithms and their testing.
4) develop critical thinking about shortcomings of the state of the art in image processing

Recommended Books:

1. *Gonzalez, R. C. and Woods, R. E., Digital Image Processing, Pearson Education (2007).*
2. *Jain, A. K., Fundamentals of Digital Image Processing, PHI (2002).*
3. *Umbaugh, S. E., Computer Imaging, Digital Image Analysis and Processing, CRC Press Book (2005).*
4. *Gonzalez, R. C., Woods, R. E. and Eddins, S. L., Digital Image Processing using MATLAB, Pearson Edition (2004).*

Evaluation Scheme:

Sr. No.	**Evaluation Elements**	**Weightage (%)**
1	MST	25
2	EST	40
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	35

PMC317: SOFTWARE ENGINEERING

L	T	P	Cr
3	0	2	4.0

Course Objectives: In this course, students will gain a broad understanding of the discipline of software engineering and its application to the development and management of software systems. The course will help students to learn the knowledge of basic SW engineering methods and practices, and their appropriate application, to understand software process models, processes of requirements analysis thorough software design concepts, tools and techniques for software construction and maintenance. Students shall be able learn various techniques, metrics and strategies for testing software projects. To learn and apply standards, CASE tools and techniques

Generic View of Software Engineering: Process models, Software requirements, Fundamentals, Requirements process, Requirements elicitation, Requirements analysis, Requirements specification, Requirements validation.

Software Project Management: Managing people, Process, Project, Software measurement, Estimation, Software risk and management, Software quality management.

Software Design: Software design fundamentals, Key issues in software design, Software structure and architecture, Software design quality analysis and evaluation, Software design notations, Software design strategies and methods

Software Construction and Maintenance: Software construction fundamentals, Managing construction, Practical considerations, Software maintenance fundamentals, Key issues, Maintenance process, Techniques for software maintenance.

Software Configuration Management: SCM process, Organizational context for SCM, Constraints and guidance for SCM process, Planning for SCM, Software configuration identification, identifying items to be controlled, Software configuration control, Software configuration Status accounting, Software configuration auditing, Software release management and delivery

Software Testing: Fundamentals, Levels of testing, testing techniques, Testing strategies.
Software Engineering Tools and Methods: Software requirements tools, Software design tools, Software construction tools, Software maintenance tools, Software configuration management tools, Software engineering process tools, CASE environments, Miscellaneous tools.

Laboratory Work:
Laboratory exercises to implement various stages of software development using Rational suite/MS Project**.** Introduction to software engineering tools, case tools.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:

1) understand software process models and apply methods for Design and Development of software projects.
2) Plan and deliver an effective software engineering process, based on knowledge of widely used development lifecycle models.
3) Understand requirements analysis for software engineering problems.
4) Understand thorough software design concepts, different software architectural styles and object oriented analysis and design using UML.

5) Learn various fundamentals, tools and techniques for software construction and maintenance.
6) Formulate a testing strategy for a software system, employing techniques such as unit testing, test driven development and functional testing.

Recommended Books:

1. *Pressman, R. S. and Pressman, R., Software Engineering: A Practitioner's Approach, McGraw- Hill International Edition (2010)*
2. *Peters, J. F. and Pedrycz, W., Software Engineering an Engineering Approach, John Wiley and Sons (2001).*
3. *Sommerville, I., Software Engineering, Pearson Education (2006).*
4. *Jalote, P., An Integrated Approach to Software Engineering, Narosa Publishing House (2005).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	35

PMC318: DESIGN AND ANALYSIS OF ALGORITHMS

L	T	P	Cr
3	0	2	4.0

Course Objectives: The aim of this course is to introduce the concepts of algorithm analysis using time complexity. This course also provides the knowledge of algorithm design methodologies

Introduction: Algorithm definition, Analyzing algorithms, Order arithmetic, Time and space complexity, Models of computation, Growth of functions, Summations, Recurrences: substitution, iteration, the master theorem.

Divide and Conquer Technique: General method, Maximum-subarray problem, Strassen's algorithm for matrix multiplication.

Greedy method: Elements of greedy strategy, Activity-selection problem, Huffman codes, Job Sequencing, Knapsack problem, Optimal merge patterns.

Dynamic Programming: Use of table instead of recursion, Rod cutting problem, Longest common subsequence problem, 0/1 knapsack problem, Optimal binary search tree problem.

Backtracking: 8 queens problem, sum of subsets, graph coloring, Knapsack problem.

NP-Completeness: P, NP, NP-Hard and NP-complete problems, Deterministic and non-deterministic polynomial time algorithm approximation, Algorithm for some NP complete problems.

Approximation algorithms: The vertex-cover problem, Travelling-salesman problem, Set-covering problem.

Laboratory Work:
Problems based upon the topics given in the syllabus should be covered in the lab.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) appreciate the requirements of algorithm analysis.
2) understand the concepts behind divide and conquer; greedy technique, backtracking and dynamic programming after going through this course.
3) understand the concept behind NP-completeness.
4) hands on experience in implementing these strategies on machine.

Recommended Books:

1. *T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stelin, Introduction to Algorithms, PHI (2010).*
2. *E. Horowitz, S. Sahni, S. Rajasekaran, Fundamentals of Computer Algorithms, University Press (India) Pvt. Ltd. (2009).*
3. *V. Aho, J. E. Hopcroft, J. D. Ullman, The Design and Analysis of Computer Algorithms, Addison-Wesley Longman (1998).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	35

PMC319: WAVELET AND APPLICATIONS

L	T	P	Cr
3	0	2	4.0

Course Objectives: The objective of this course is to cover the basic theory of wavelets, multiresolution analysis, construction of scaling functions, bases, frames and their applications in various scientific problems.

Different Ways of Constructing Wavelets: Orthonormal bases generated by a single function, The Balian-low theorem, Smooth projections on L2(R), Local sine and cosine bases and the construction of some wavelets, The unitary folding operators and the smooth projections.

Multiresolution Analysis: Multiresolution analysis and construction of wavelets, Construction of compactly supported wavelets and estimates for its smoothness, Band limited wavelets, Orthonormality, Completeness, First and second generation wavelet transform.

Characterizations in the Theory of Wavelets: Basic equations and some of its applications, Characterizations of MRA wavelets, Characterization of Lemarie-Meyer wavelets and some other characterizations, Franklin wavelets and spline wavelets on the real line, Orthonormal bases of piecewise linear continuous functions for L2(T).

Wavelets in Signal and Image Processing: Signals, Filters, Coding signals, Filters banks, Image analysis, Image compression.

Laboratory Work:
Analysis of different wavelet filters, Multiresolution analysis feature of different wavelets, Applications of wavelets in signal and image processing.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) understand the properties of various scaling functions and their wavelets.
2) understand the properties of multiresolution analysis.
3) construct the scaling functions using infinite product formula and iterative procedure.
4) implement wavelets in various problems like image compression, denoising *etc*.

Recommended Books:

1. *Eugenio, H. and Guido, W., A First course on Wavelets, CRC Press, New York (1996).*
2. *Chui, C. K., An Introduction to Wavelets, Academic Press (1992).*
3. *Meyer Y., Wavelets, Algorithms and Applications, SIAM (1994)*
4. *Daubechies, I., Ten Lectures on Wavelets, CBS-NSF regional conferences in applied mathematics, 61, SIAM (1992)*
5. *Gonzalez, R. C. and Woods, R. E., Digital Image Processing, Pearson Education, (2007).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes/Lab Evaluation)	35

PMC323: THEORY OF COMPUTATION

L	T	P	Cr
3	0	2	4.0

Course Objectives: The objective of the course is to introduce students the areas of computability and fundamental topics in Computer Science. The course also facilities life-long learning experience in Computer Science by providing the students with foundational material that continues to be applicable even as the discipline rapidly evolves.

Recursive Languages: Recursive definition, Alphabets, Language, Regular expression, Definitions of finite state machine, Transition graphs, Deterministic & non-deterministic finite state machines, Regular grammar, left linear and right linear, Thomson's construction to convert regular expression to NDFA& subset algorithm to convert NDFA to DFA, Minimization of DFA, Finite state machine with output (Moore machine and Melay Machine), Conversion of Moore machine to Melay machine & vice-versa.

Properties of Regular languages: Conversion of DFA to regular expression, Pumping lemma, Properties and limitations of finite state machine, Decision properties of regular languages, Application of finite automata.

Context Free Grammar and PDA: Context free grammar, writing context free grammar for problems, Derivation tree and ambiguity, Application of context free grammars, Chomsky and Greibach normal form, Conversion of CFG to CNF and GNF, Properties of context free grammar, CYK algorithm, Decidable properties of context free grammar, pumping lemma for context free grammar, Push down stack machine, Design of deterministic and non-deterministic push-down stack, Parser design.

Turing Machine: Turing machine definition and design of turing machine, Church-turing thesis, variations of turing machines, Universal turing machine, Post machine, Chomsky Hierarchy.

Computation Complexity: P, NP and NP complete problems.

Laboratory Work:
Lab work will be based on the program design of pattern matching in C language. Program design in LEX using regular expression and integration with YACC

Course Learning Outcomes (CLO):
Upon completion of the course, students will be able to:
1. possess the skills of master regular languages and finite automata
2. possess the skills of master context-free languages, push-down automata and Turning recognizable languages.
3. exposed to a broad overview of the theoretical foundations of computer science.
4. familiar with thinking analytically and intuitively for problem-solving situations in related areas of theory in computer science.

Recommended Books:

1. *Daniel A. Cohen, Introduction to Computer Theory, John Wiley and Sons (1996).*
2. *Hopcroft John E., Ullman Jeffrey D., and Motwani R., Introduction to Automata Theory, Languages and Computation, Pearson Education (2006).*
3. *Michael Sipser, Introduction to the Theory of Computation, Thomson (2007).*
4. *Lewis Harry R., Elements of Theory of Computation, PHI (1997).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	35

PMC324: WIRELESS NETWORKS AND MOBILE COMPUTING

L	T	P	Cr
3	0	2	4.0

Course Objectives: The course has been introduced with an intention to provide knowledge of wireless communication, media requisites, challenges and a comparative analysis with wired networks. The contents groom a learner in the area of cellular communication, concept of frequency, wireless standards and concept of wireless integration with traditional wired networks.

Introduction to wireless networking, advantages and disadvantages of wireless networking, Characteristics of radio propagation, Fading, multipath propagation

Wireless Communication Systems: Evolution of mobile communication generations, Cellular concept, Frequency reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, Trunking and grade of services, Improving coverage and capacity in cellular systems

Medium Access Control: MAC protocols for digital cellular systems such as GSM, MAC protocols for wireless LANs such as IEEE 802.11, a, b, g and HIPERLAN I and II, the near far effect, Hidden and exposed terminals, Collision avoidance (RTS, CTS) protocols.

Bluetooth: Radio specification, baseband specification, Link manager specification, Logical link control and adaptation protocol.

Transport Over Wireless Networks- Introduction, TCP over wireless networks, Approaches to improve transport layer performance, Mobile adhoc networks.

Laboratory Work:
The lab work will be based on the configuration of wireless LANs using access points, Routers etc, Implementation of WAP protocol stack, Wireless programming using Bluetooth, RFID, GSM and Wi-Fi development kits etc.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:

1. learn wireless network standards
2. know the construction and working of wireless networks
3. compare and contrast wire and wireless networks
4. understand issues of data communication and channelization
5. appreciate concept of wireless technologies

Recommended Books:

1. *Stallings W., Wireless Communications and Networks, Pearson Education (2005).*
2. *Stojmenic I., Handbook of Wireless Networks and Mobile Computing, John Wiley (2002).*
3. *Rappaport T.S., Wireless Communications- Principle and Practices, PHI (2002).*
4. *Lin Yi Bing and ChlamtacImrich, Wireless and Mobile Network Architectures, John Wiley (2000).*
5. *Pandya R., Mobile and Personal Communications Systems and Services, PHI (2004).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	35

PMC325: INFORMATION AND NETWORK SECURITY

L	T	P	Cr
3	0	2	4.0

Course Objectives: Understanding of basic concepts, services, threats and principles in network security. Comprise and implement various cryptographic techniques. Implement protocols like SSL, SSH. Implementation of email security services, authentication services, web security services. Comprise security services and mechanisms in the network protocol stack**.** Firewall requirements and its configuration.

Introduction: Security problem in computing, Elementary cryptography introduction, Substitution ciphers, Transpositions encryption algorithms DES, AES, Public key encryption, Uses of encryption, Program security, Secure programs, Non malicious program errors, Viruses and other malicious code, Targeted malicious code, Controls against program threats.

Protection in General Purpose Operating Systems: Protected objects and methods of protection, Memory and address protection, Control of access to general objects, File protection mechanisms, User authentication, Designing, trusted operating systems, Security policies, Models of security, trusted operating system design, Assurance in trusted operating systems.

Security in Networks: Threats in networks, Network security controls, Firewalls, Intrusion detection systems, Sniffers: Passive sniffing, Active sniffing, Spoofing and sniffing attacks, ARP poisoning and countermeasures, Denial of service: Goals, Impact and modes of attack, Internet security architectures- Basic security deficits of Internet protocol, IPSec, Authentication header (AH), Encapsulating security payload (ESP).
Session hijacking, Spoofing vs hijacking, Steps in session hijacking, Types of session hijacking, Protocol vulnerabilities- examples of protocol vulnerabilities, Secure socket layer/ transport layer security, Secure shell (SSH), Firewall architectures, packet filtering, proxy services and bastion hosts.

Laboratory Work:
The lab work will include implementation of algorithms of cryptography in network security, the lab work will include firewall implementation, SSH, Certificates and security tools implementation, Database security, Program security etc.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1. Understand Security trends.
2. Implement various cryptographic algorithms.
3. Understand various mechanism to protect Operating System from threats
4. Understand the various type of system attacks and their countermeasures.
5. Configuration of firewalls

Recommended Books:

1. *Charles. P. Pfleeger and Shari Lawrence Pfleeger, Security in Computing, Pearson Education (2002).*
2. *William Stallings, Network Security Essentials, Applications and Standards, Pearson Education (2008)*
3. *Stallings W., Cryptography and Network Security Principles and practice, Pearson Education (2003).*
4. *Michael. E. Whitman and Herbert J. Mattord Principles of Information Security, Course Technology (2004).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes/Lab Evaluation)	35

PMC411: NUMERICAL METHODS FOR PARTIAL DIFFERENTIAL EQUATIONS

L	T	P	Cr
3	0	0	3.0

Course Objectives: This course deals with the mathematical theory of numerical methods especially finite difference and finite element methods used to solve partial differential equations (PDEs). In this course, students will study algorithms and methods to obtain numerical results for different kind of physically important PDEs system like Laplace, Poisson, Heat and Wave equations. Student will study analysis and applications of finite difference methods and finite element methods for the numerical solutions of various elliptic, hyperbolic and parabolic PDEs**.**

Parabolic Equations: Numerical solutions of parabolic equations of second order in one space variable with constant coefficients – two and three levels explicit and implicit difference schemes, Truncation errors and convergence analysis, Numerical solution of parabolic equations of second order in two space variable with constant coefficients-improved explicit schemes, Larkin modifications, Implicit methods, alternating direction implicit (ADI) methods, Difference schemes for parabolic equations with variable coefficients in one and two space dimensions.

Hyperbolic Equations: Hyperbolic equations in one dimension. Upwind and Lax Wendroff approximations, extension to higher space dimension.

Elliptic Equations: Numerical solutions of elliptic equations, Approximations of Laplace and biharmonic operators, Solutions of Laplace and Poisson equations with Dirichlet, Neumann and mixed boundary in rectangular, Circular and triangular regions, ADI methods.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:

1) find numerical solutions of heat conduction diffusion equation in one and two space variables with the aid of Bendre Schmidt explicit scheme, Crank Nicholson scheme, Du-Fort and Frankel Scheme etc.
2) carry out the stability analysis and truncation error in various aforementioned numerical schemes.
3) apply difference schemes in spherical and cylindrical coordinate systems in one dimension parabolic equations
4) calculate the numerical solution of hyperbolic equations of second order in one and two space variables with explicit and implicit methods and ADI method
5) approximate Laplace and biharmonic operators.
6) solve the Dirichlet, Neumann and mixed type problems with Laplace and Poisson equations in rectangular, circular and triangular regions.

Recommended Books:

1. *K. W. Morton and D. F. Mayers, Numerical solution of Partial Differential Equations, Cambridge press, (2005).*
2. *John C. Strikewerda, Finite Difference equations, schemes and Partial Differential Equations, SIAM, (2004).*
3. *Langtangen H.P., Computational Partial Differential Equations Springer Verlag (2003).*
4. *Gupta R.S., Elements of Numerical Analysis, Macmillan India Ltd (2008).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	50
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	20

PMC422: FLUID MECHANICS

L	T	P	Cr
3	0	0	3.0

Course Objectives: This course is intended to provide a treatment of topics in fluid mechanics to a standard where the student will be able to apply the techniques used in deriving a range of important results and in research problems. The objective is to provide the student with knowledge of the fundamentals of fluid mechanics and an appreciation of their application to real world problems.

Kinematics: Lagrangian and Eulerian methods, Equation of continuity, Stream lines, Path lines and streak lines, Velocity potential and stream function, Irrotational and rotational motions.

Dynamics: Euler's equation, Bernoulli's equation, Equations referred to moving axes, Impulsive actions, Vortex motion and its elementary properties, Motions due to circular and rectilinear vortices, Kelvin's proof of permanence.

Potential Flow: Irrotational motion in two-dimensions, Complex-velocity potential sources, Sinks, Doublets and their images, Conformal mapping.

Laminar Flow: Stress components in a real fluid, Navier-Stokes equations of motion, Plane poiseiuille and couette flows between two parallel plates, Flow through a pipe of uniform cross section in the form of circle, Annulus, Theory of lubrication.

Boundary Layer Flows: Boundary layer thickness, Displacement thickness, Prandit's boundary layer, Boundary layer equations in two dimensions, Blasius solution, Karman integral equation, Separation of boundary layer flow.

Course Learning Outcomes (CLO):

Upon completion of this course, the student will be able to:

1) Understand the basic principles of fluid mechanics, such as Lagrangian and Eulerian approach, conservation of mass etc.
2) Use Euler and Bernoulli's equations and the conservation of mass to determine velocity and acceleration for incompressible and inviscid fluid.
3) Understand the concept of rotational and irrotational flow, stream functions, velocity potential, sink, source, vortex etc.
4) Analyse simple fluid flow problems (flow between parallel plates, flow through pipe etc.) with Navier - Stoke's equation of motion.
5) understand the phenomenon of flow separation and boundary layer theory.

Recommended Books:

1. *Yuan S.W., Foundations of Fluid Mechanics, Prentice Hall of India Private Limited (1976).*
2. *Chorlton F., Textbook of Fluid Dynamics, C.B.S. Publishers (2005).*
3. *Besant W.H., and Ramsay A.S., Treatise of Hydro Mechanics, Part II, CBS Publishers (2004).*
4. *RathyR.K., An Introduction to fluid Dynamics, Oxford and IBH Publishing Company (1976).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	50
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	20

PMC423: ALGEBRAIC CODING THEORY

L	T	P	Cr
3	0	0	3.0

Course Objectives: The objective of the course is to introduce basic topics of algebraic coding theory like error correction and detection, linear codes, Hamming codes, finite fields and BCH codes, dual codes and the weight distribution, cyclic codes, generator polynomial and check polynomial.

Introduction to Coding Theory: Code words, Distance and weight function, Nearest-neighbor decoding principle, Error detection and correction, Matrix encoding techniques, Matrix codes, Group codes, Decoding by coset leaders, Generator and parity check matrices, Syndrom decoding procedure, Dual codes.

Linear Codes: Linear codes, Matrix description of linear codes, Equivalence of linear codes, Minimum distance of linear codes, Dual code of a linear code, Weight distribution of the dual code of a binary linear code, Hamming codes.

BCH Codes: Polynomial codes, Finite fields, Minimal and primitive polynomials, Bose-Chaudhuri-Hocquenghem codes.

Cyclic Codes: Cyclic codes, Algebraic description of cyclic codes, Check polynomial, BCH and Hamming codes as cyclic codes.

MDS Codes: Maximum distance separable codes, Necessary and sufficient conditions for MDS codes, Weight distribution of MDS codes.

Algebraic Coding Theory: Overview of coding theory, Error detecting and correcting codes.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) Learn about basic techniques of algebraic coding theory like matrix encoding, polynomial encoding, and decoding by coset leaders etc.
2) Different types of codes like linear, BCH, cyclic and MDS codes.
3) learn how algebraic coding theory is applicable in real world problems.

Recommended Books:

1. *Vermani L R, Elements of Algebraic Coding Theory, Chapman and Hall (1996).*
2. *Vera P., Introduction to the Theory of Error Correcting Codes, John Wiley and Sons (1998).*
3. *Roman Steven, Coding and Information Theory, Springer Verlag (1992).*
4. *Garrett Paul, The Mathematics of Coding Theory, Pearson Education (2004).*
5. *Vermani, L.R., Elements of Algebraic Coding Theory, Chapman and Hall (1996).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	50
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	20

PMC424: FINITE ELEMENT METHODS

L	T	P	Cr
3	0	0	3.0

Course Objectives: The objective of the course includes an introduction about different finite element methods in one-, two- and three-dimensions. The course focuses on analyzing variety of finite elements as per the requirements of solutions of differential equations.

Introduction: Finite element methods, History and range of applications.

Finite Elements: Definition and properties, Assembly rules and general assembly procedure, Features of assembled matrix, Boundary conditions.

Continuum Problems: Classification of differential equations, Variational formulation approach, Ritz method, Generalized definition of an element, Element equations from variations, Galerkin's weighted residual approach, Energy balance methods.

Element Shapes and Interpolation Functions: Basic element shapes, Generalized co-ordinates, Polynomials, Natural co-ordinates in one- two- and three-dimensions, Lagrange and hermite polynomials, Two-D and three-D elements for C^o and C^1 problems, Co-ordinate transformation, Iso-parametric elements and numerical integration, Application of finite element methods to heat transfer problems.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1. Formulate simple problems into finite elements.
2. Solve the elasticity and the heat transfer problems.
3. Solve the complicated two- and three-dimensional problems.
4. Appreciate the importance of finite element methods for solving real life problems arising in various fields of science and engineering.

Recommended Books:

1. *Bathe, K.J., Finite Element Procedures, Prentice Hall (2008).*
2. *Cook, R.D., Malkus, M.E.P. and Witt, R.J., Concepts and Applications of Finite Element Analysis, John Wiley and Sons (2001).*
3. *Reddy, J.N., An Introduction to the Finite Element Methods, McGraw-Hill (2006).*
4. *Thomson E. G., Introduction to the Finite Element: Theory, Programming and applications, Willey, (2004).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	50
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	20

PMC301: TOPOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objectives: This course aims to teach the fundamentals of point set topology and constitute an awareness of need for the topology in Mathematics.

Topological Spaces: Review of metric spaces, Definition and examples of topological spaces, Topology induced by a metric, closed set, Closure, Dense subsets, Neighborhood, Interior, Exterior, Boundary and accumulation points and derived sets, Bases and sub bases, Topology generated by sub bases, Subspaces and relative topology, Continuous function and homeomorphism.

Countable Spaces: First and second countable spaces, Lindelof spaces, Separable spaces, Second countability and separability, Separation axioms (T_0, T_1, T_2, T_3, regular and normal spaces), Urysohn's lemma, Tietze extension theorem.

Compact and Connected Spaces: Compact spaces and their basic properties, Pseudocompact spaces and countably compact spaces, connected spaces, connected sets in the real line, totally disconnected spaces, Intermediate value theorem, Path connected components, locally connected spaces, totally disconnected spaces, Continuous functions and connected sets.

Basis and dimension

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) Understand to construct topological spaces from metric spaces and using general properties of neighborhoods, open sets, close sets, basis and sub-basis.
2) Apply the properties of open sets, close sets, interior points, accumulation points and derived sets in deriving the proofs of various theorems.
3) To understand the concepts of countable spaces and separable spaces.
4) Understand the concepts and properties of the compact and connected topological spaces.

Recommended Books:

1) Kelley, J.L., General Topology, Springer (1955).
2) Simmons, G.F., Introduction to Topology and Modern Analysis, Tata McGraw Hill (1963).
3) Munkers James R., Topology: a first course, PHI (2007).
4) Joshi, K.D., Introduction to General Topology, Wiley (1983).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	50
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	20

PMC426: NUMBER THEORY AND CRYPTOGRAPHY

L	T	P	Cr
3	0	0	3.0

Course Objectives: The purpose of the course is to give a simple account of classical number theory, prepare students to graduate-level courses in number theory and algebra, and to demonstrate applications of number theory (such as public-key cryptography). Upon completion of the course, students will have a working knowledge of the fundamental definitions and theorems of elementary number theory, be able to work with congruences, solve congruence equations and systems of equations with one and more variables, and be literate in the language and notation of number theory. They will also have an exposure to cryptography.

Divisibility: Greatest common divisor, Fundamental theorem of arithmetic, Congruence, Residue classes and reduced residue classes, Euler's theorem, Fermat's theorem, Wilson Theorem, Chinese remainder theorem with applications.

Polynomial Congruences: Primitive roots, Indices and their applications, Quadratic residues, Legendre symbol, Euler's criterion, Gauss's Lemma, Quadratic reciprocity law, Jacobi symbol.

Arithmetic Functions: $\phi(x),\ d(x),\ \mu(x),\ \sigma(x)$, Mobius inversion formula, LinearDiophantine equations

Farey Series: Continued fractions, Approximations of reals by rationals, Pell's equation.

Introduction to Cryptography- Encryption schemes, Cryptanalysis, Block ciphers, Stream ciphers.

Public Key Encryption- RSA cryptosystem and Rabin encryption.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:

1) understand the properties of divisibility and prime numbers, compute the greatest common divisor and least common multiples and handle linear Diophantine equations.
2) understand the operations with congruences, linear and non-linear congruence equations
3) understand and use the theorems: Chinese Remainder Theorem, Lagrange theorem, Fermat's theorem, Wilson's theorem.
4) Use arithmetic functions in areas of mathematics.
5) Understand continue fractions and will be able to approximate reals by rationals,
6) understand the basics of RSA security and be able to break the simplest instances.

Recommended Books:

1. *Hardy and Wright W.H., Theory of Numbers, Oxford University Press (1979).*
2. *Niven I., Zuckerman S.H. and Montgomary L.H., An Introduction to Theory of Numbers, John Wiley and Sons (1991).*
3. *Davenport H., Higher Arithmetic, Cambridge University Press (1999).*
4. *David M. Burton, Elementary Number Theory, Wm. C.brown Publishers, Dubuque, Ivova (1989).*
5. *Johannes A. Buchmann, Introduction to Cryptography, Springer Verlag (2001).*

6. *Bruce Schneier, Applied Cryptography, John Wiley and Sons (1996).*

Evaluation Scheme:

Sr. No.	**Evaluation Elements**	**Weightage (%)**
1	MST	30
2	EST	50
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	20

PMC427: FUZZY SETS AND APPLICATIONS

L	T	P	Cr
3	0	0	3.0

Course Objectives: The objective of this course is to teach the students the need of fuzzy sets, arithmetic operations on fuzzy sets, fuzzy relations, possibility theory, fuzzy logic, and its applications

Classical and Fuzzy Sets: Overview of classical sets, Membership function, A-cuts, Properties of a-cuts, Extension principle.

Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of operations, Aggregation operations.

Fuzzy Arithmetic: Fuzzy numbers, Linguistic variables, Arithmetic operations on intervals and numbers, Fuzzy equations.

Fuzzy Relations: Crisp and fuzzy relations, Projections and cylindric extensions, Binary fuzzy relations, Binary relations on single set, Equivalence, Compatibility and ordering Relations, Morphisms, Fuzzy relation equations.

Possibility Theory: Fuzzy measures, Evidence and possibility theory, Possibility versus probability theory.

Fuzzy Logic: Classical logic, Multivalued logics, Fuzzy propositions, Fuzzy qualifiers, Linguistic hedges.

Applications of Fuzzy Logic: Washing machines, Control systems engineering, Power engineering and Optimization.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:

1) construct the appropriate fuzzy numbers corresponding to uncertain and imprecise collected data.
2) handle the problems having uncertain and imprecise data.
3) find the optimal solution of mathematical programming problems having uncertain and imprecise data.
4) Deal with the fuzzy logic problems in real world problems.

Recommended Books:

1. *KlirG.J. and Folger T.A., Fuzzy Sets, Uncertainty and Information, PHI (1988).*
2. *KlirG.J. and Yuan B., Fuzzy Sets and Fuzzy logic: Theory and Applications, PHI (1995).*
3. *Zimmermann H.J., Fuzzy Set Theory and its Applications, Allied Publishers (1991).*
4. *Mohan, C., Fuzzy Set and Logic*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	50
3.	Sessionals (May include assignments/quizzes/Lab Evaluation)	20

PMC432: ADVANCED OPERATIONS RESEARCH

L	T	P	Cr
3	0	0	3.0

Course Objectives: The objective of this course is to teach the basic concepts of non-linear programming problems as well as the methods to solve quadratic programming problems, goal programming problems, dynamic programming problems, multi-objective programming problems and search technique to find the solution of unconstrained optimization problems.

Nonlinear Programming: Convex functions and their subgradients, Differentiable and twice differentiable convex functions and their properties, Convex programming problem, Maxima and minima of convex functions, Generalized convexity, Quasiconvex functions, Strictly and strongly quasiconvex functions, Pseudo convex functions and their properties, Ist order Karush Kuhn Tucker (KKT) optimality conditions.

Quadratic Programming: Wolfe and Beale’s algorithm, Wolfe’s duality and related results.

Goal Programming: Graphical solution.

Search Techniques: Direct search and gradient methods, Unimodal functions, Fibonacci method, Golden section method, Method of steepest descent, Newton-Raphson method, Hooke's and Jeeve's method, Conjugate gradient methods.

Multi-Objective Programming: Non dominated criteria vector and efficient point, weakly and strictly efficient solutions, Proper efficiency and proper non-dominance, efficient solutions, Domination cones, Weighted sum approach.

Course Learning Outcomes (CLO):

Upon completion of this course, the student will be able to:

1) Understand the concept of convexity and generalized convexity.
2) To derive the necessary conditions (KT conditions) for constrained nonlinear optimization problems.
3) To solve quadratic, goal and multi-objective programming problems.
4) Use search technique to find the optimal solution of unconstrained optimization problems.

Recommended Books:

1. *Bazaarra Mokhtar S., Jarvis John J., and ShiraliHanif D., Nonlinear Programming, John Wiley and Sons (1990).*
2. *SteuerR.E., Multi Criteria Optimization: Theory, Computation and Application, John Wiley and Sons (1986).*
3. *MangsarianO.L., Non-linear Programming, SIAM (1994).*
4. *C.Mohan and Kusumdeep, Optimization Techniques, New Age International Pvt. Ltd., (2009).*
5. *Chandra, S., Jayadeva, Mehra, A., Numerical Optimization and Applications, Narosa Publishing House, (2013).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	50
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	20

PMC433: THEORY OF ELASTICITY

L	T	P	Cr
3	0	0	3.0

Course Objectives: This course is intended to provide a basic treatment of the formulation of linear elasticity theory and its application to problems of stress and displacement analysis. The objective is to provide the student knowledge of fundamentals of theory of elasticity and an appreciation of their application to the different fields of research.

Tensor Algebra: Scalar, Vector, Matrix and tensor definition, Index notation, Kroneckor delta and alternating symbol, Coordinate-transformation, Cartesian tensor of different order, Properties of tensors, Isotropic tensors of different orders and relation between them, Symmetric and skew-symmetric tensors, Covariant, Contra variant and mixed tensors, Sum and product of tensors.

Analysis of Stress: Stress vector, Stress components, Stress tensor, Symmetry of stress tensor, Stress quadric of Cauchy, Principal stress and invariants, Maximum normal and shear stresses.

Analysis of Strain: Affine transformations, Infinitesimal affine deformation, Geometrical interpretation of the components of strain, Strain quadric of Cauchy, Principal strains and invariants, General infinitesimal deformation, Finite deformations, Examples of uniform dilatation, Simple extension and shearing strain.

Equations of Elasticity: Generalized Hooke's law, Hooke's law for Homogeneous isotropic media, Elastic moduli for isotropic media, Equilibrium and dynamic equations for an isotropic elastic solid, Beltrami-Michell compatibility equations, Strain energy function.

Elastic Waves: Simple harmonic progressive waves, Scalar wave equation, Progressive type solutions, Plane waves, Propagation of waves in an unbounded elastic solid media, P, SV and SH waves, Elastic surface waves as Rayleigh waves, Love waves.

Applications to different elastic models.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) Understand the notation and properties of different types of tensor.
2) Learn various terms related to stress tensor like normal and shear stress, stress quadric of Cauchy, Principal stress and invariants.
3) Learn affine transformations and geometrical interpretation of the components of strain and terms related to strain tensor.
4) Understand the generalized Hooke's law, reduction of elastic constants to different elastic models from the most general case.
5) Develop equilibrium and dynamical equations of an isotropic elastic solid.
6) Learn some important aspects of wave propagation in the infinite and semi-infinite solids.

Recommended Books:

1. *I.S. Sokolnikoff, Mathematical Theory of Elasticity, Tata McGraw Hill Publishing Company Ltd., New Delhi, (1977).*
2. *D.S. Chandrasekharaiah, Continuum Mechanics, Academic Press, Prism Books Pvt. Ltd., Bangalore*

3. *K.F.Graff, Wave Motion in Elastic Solids. Dover, New York, (1991).*
4. *U.C.De., Tensor Calculus, Narosa Publishing House.*
5. *Shanti Narayan, Text Book of Cartesian Tensor, S.Chand & Co. (1950).*

Evaluation Scheme:

Sr. No.	**Evaluation Elements**	**Weightage (%)**
1	MST	30
2	EST	50
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	20

PMC430: MODELING OF STELLAR STRUCTURE

L	T	P	Cr
3	0	0	3.0

Course Objectives: The goal of this course is to familiarize the students with the basic observed properties of stars and to provide them the knowledge of basic physics and fundamental properties that govern stars and their structures. The aim of this course is also to understand mathematical techniques to solve the stellar structure equations and apply the basic theory of stellar structures on analytical models.

Observed Properties of the Stars: Introduction to stars**,** Measurement of stellar distances, Luminosities, Temperatures, Masses and radii, The Hertzsprung-Russell diagram.

Fundamental Equations of Stellar Structure: Time scales, Fundamental equations: Mass conservation, Hydrostatic equilibrium, Energy transport, The virial theorem. Radiative transport and convection.

Boundary Value Problems: Shooting method and relaxation method, Applications to stellar structure with detailed discussion of Henyey scheme and EZ – Code**.**

Stellar Modeling and Numerical Calculations: Russell-Voigt theorem, Limits to the mass, solving the coupled equations, Simple analytic stellar models: Polytropes and other relations, Numerical models, The Edington luminosity, Dimensional analysis and mass-radius relations, The HR diagram.

Superdense Objects: Use of polytropic models for completely degenerate stars, Mass-radius relation, Non-degenerate upper layers and abundance of Hydrogen, Stability of white dwarfs.

Course Learning Outcomes (CLO):
Upon completion of this course, the student will be able to:
1) Understand the various properties of stars.
2) Understand the basic physics and fundamental properties that govern star and their structure.
3) learn the mathematical methods to solve stellar structure equations.
4) Develop mathematical methods of stellar structures and their solution techniques.
5) Study the various properties of super dense objects like white dwarf stars.

Recommended Books:

1. *Chandrasekhar, S., An introduction to the Study of Stellar Structure, University of Chicago Press, Reprinted by Dover, (1939).*
2. *Kippenhahn, R and Weigert, A., Stellar Structure and Evolution, Springer-Verlag, (1990).*
3. *Schwarzschild, M., Structure and Evolution of the Stars, Princeton University Press, Reprinted by Dover, (1958).*
4. *Prialnik, D., An Introduction to the Theory of Stellar Structure and Evolution, CUP, (2000).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	50
3	Sessionals (May include assignments/quizzes/Lab Evaluation)	20