SHRI G. S. INSTITUTE OF TECHNOLOGY AND SCIENCE, INDORE
(GOVERNMENT AIDED AUTONOMOUS INSTITUTE)

DEPARTMENT OF
APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE

Syllabi of PG Subjects

(Approved by B.O.S. held on 18-07-2023 and Academic Council held on 14- 09 – 2023)

INDEX

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE
M.Sc. I Semester
MA 94105: COMPUTER AIDED NUMERICAL ANALYSIS

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
T	P	TU	T	P	TU	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
4	--	--	4	--	--	30	70	--	--	100

COURSE OBECTIVES

To differentiate between numerical methods and numerical analysis and to apply numerical analysis concepts for solving various analytical and real life problems.

COURSE OUTCOMES

After completion of the course, students are able to

- acquire knowledge of numerical analysis and fundamentals of programming
- solve the algebraic, transcendental and system of linear equation using numericalmethods
- understand the concept of interpolation and apply it in finding the differentiation and integration
- understand the concept and applications of difference equations
- apply the numerical methods to solve ordinary and partial differential equations

COURSE CONTENTS

THEORY

Unit 1 Errors and approximations, Number representation, Numerical Analysis and numerical Methods, Numerical stability, ill condition and convergence, numerical algorithm and Numerical Flow Charts, an Introduction of MATLAB, overview of C features its use in Numerical Methods.

Unit 2 Solution of Algebraic and Transcendental Equations: Bisection (or Bolzano) method, method of false position, Newton Raphson method. Solution of Simultaneous algebraic equations: Direct method- Gauss Elimination method Gauss Jordan method, Iterative method-Jacobi’s method, Gauss Seidal method.

Unit 3 Interpolation: Introduction, Interpolating polynomial, Missing term techniques, Newton's forward and backward interpolation formula, central difference formula, Lagrange's interpolation formula for unequal distances. Numerical differentiation:derivativesfromforwardandbackwardinterpolations,NumericalInteg ration: General quadrature formula, formulae derived from it.

Unit 4 Difference equations: Definition, formation of difference equations, lineardifferenceequations with constant coefficients. Difference equations reducible to linear form. Simultaneous difference equations with constant coefficient.

Unit 5 Numerical solution of Ordinary Differential Equations: Initial value problem, Euler'smethod, Picard's method, Taylor's method, modified Euler's method, Rungemethod, Runge-Kutta method, Adams-Bashforth method, Milne's method. Numericalsolution of Partial Differential Equations: Classification of second order equations, finite difference approximations to partial derivatives. Elliptic, Parabolicand Hyperbolic equations.

ASSESSMENT

1. Internal Assessment for continuous evaluation, mid-term tests, , tutorials, class performance, etc. (30%).
2. End semester Theory Exam (70%)

TEXT BOOKS RECOMMENDED

1. K SankaraRao, Numerical methods for Scientist and Engineers, Prentice Hallof India.
2. Balaguruswamy E., Numerical methods, Tata McGraw-Hill Publishing Company Ltd., NewDelhi.

REFERENCE BOOKS

1. PradeepNiyogi, Numerical Analysis and Algorithm, Tata Mcgraw-HillPublishing Com.Ltd, NewDelhi.
2. Jain N.K., Iyengar, S.R.K. and Jain R.K., Numerical methods for scientific and Engineering Computations, Wile Eastern Ltd.,1984.
3. Steven C. Chapra and Raymond P. Candle, Numerical methods for Engineers, 5th edition, Tata McGraw hill publishing company Ltd., New Delhi2006.

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE
M.Sc. I Semester
MA 94106: COMPUTER ARCHITECTURE

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
T	P	TU	T	P	TU	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
4	--	--	4	--	--	30	70	--	--	100

COURSE OBJECTIVE

To introduce the general concepts of digital logic design and its applications, architecture of memory and I/O organization in a computer system and fundamentals concepts of parallel computing, pipeline processing, vector processing and array processing.

COURSE OUTCOMES

After completion of the course, students will be able to

- acquire the knowledge ofnumber systems, general concepts of digital devices and their use in combinational and sequential logic circuit design and solve Boolean expression using Karnaugh map method.
- understand the working process, structure and **organization of various parts of a system memory hierarchy and CPU.**
- understand the internal organization of DMA, Input/Outputs processor and relations between their main components.
- acquire the knowledge of advanced concepts of parallel processing, different types of Inter processor arbitration techniques, inter processor communication and synchronization.
- Understand **the fundamentals concepts of pipeline processing, vector processing**, array processing and RISC/CISC architectures.

COURSE CONTENTS

THEORY

Unit 1 Introduction to CA : Number system , Von Neumann Model , Digital devices: Logic gates , flip flops , Logic Design : Boolean Algebra , K-map , Method of simplification of Logic expression , Combinational & Sequential circuits.

Unit 2 CPU Organization: ALU, Control unit, Registers, Memory organization, memory properties, Associative memory, Cache memory, machine language level, instruction types, Input Output Organization: I/O interface. Modes of transfer.

Unit 3 Memory: Memory mapped I/O and I/O mapped I/O, programmed I/O, concepts of interrupts and DMA, I/O processors, concept of hardwired and micro programmed control instruction.

Unit 4 Introduction to advanced architecture: Parallel processing, Interconnection structure, Interprocessor Arbitration: Serial, Parallel and Dynamic arbitration Procedure, Interprocessor Communication and Synchronization, Cache Coherence.

Unit 5 Pipeline processing: Concepts , Arithmetic and Instruction Pipeline , Vector, and Array processing: vector operation, matrix multiplication, memory interleaving, AttachedarrayProcessor,SIMDArrayProcessor.ComparisonofRISCand CISC.

ASSESSMENT

1. Internal Assessment for continuous evaluation, mid-term tests, tutorials, class performance, etc. (30%).
2. End semester Theory Exam (70%)

TEXT BOOKS RECOMMENDED

1. Moris Mano, Computer System Architecture, Prentice Hall of India.
2. William Stallings, Computer Organization and Architecture, 7th Edition, Pearson Education Prentice Hall of India,2009.

REFERENCE BOOKS

1. Andrew S.Tanenbaum, Structured Computer organizations, 5th Edition, Pearson Education Prentice Hall of India,2006.
2. A.P.Godse and D.A.Godse, Computer Architecture, 4thEdition, Technical Publications Pune,2009.

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE
M.Sc. I Semester
MA 94108: ADVANCE DISCRETE MATHEMATICS AND ALGEBRA

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
T	P	TU	T	P	TU	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
4	--	--	4	--	--	30	70	--	--	100

COURSE OBJECTIVE

To introduce the concept of set theory, Boolean algebra, Graph theory, Automatatheory, theory of formal languages, grammars, ring and field theory.

COURSE OUTCOMES

After completion of the course, students are able to

- understand the basic concepts of set theory, Boolean algebraand mathematical logic for analyzing prepositions.
- understand various graphs, solving minimal weight problems and shortest path problems using suitable algorithm in graph theory.
- understand basic properties of formal languages, grammars and finite automata.
- understand ring theory and modules theory with their properties.
- Apply basic theory of vector space in field extensions.

COURSE CONTENTS

THEORY

Unit 1 Formal Logic: Basic preliminaries Sets, functions, relations (equivalence relations and poset) for logic and subsequent development; statements, symbolic representation and tautologies, Quantifiers, Predicates, Propositional and Predicate calculus, Proofs & method of proofs, Algebra and Lattices: Boolean expression, Logic gates and circuits, Karnaugh maps, Lattices, Distributive lattice.

Unit 2 Graph Theory: Definition of (Undirected) Graphs, Paths, Circuits, Cycles and Subgraphs, Degree of Vertex ,Connectivity, Complete regular and bipartite graphs and Complete Bipartite Graphs, Kuratowskis Theorem (Statement only) and its uses, planer graphs and their properties, Euler’s formula for connected Planer Graphs, Graph colourings, directed graphs, Trees and Binary Trees, Spanning Trees, Cut-sets, Minimal Spanning Trees, Euler’s Theorem on the existence of Eulerian paths and circuits, Directed Graphs, In degree and Out degree of a vertex, weighted undirected graphs, Matrix representation of Graph.

Unit 3 Introduction to Languages, Operation on Languages, Regular Expression, Regular Languages, Grammars, Language generated by a grammar,Types of Grammars, Finite State Automata, Pumping Lemma , Finite State Machine, Turing Machine.

Unit 4 Algebra: Review of basic concepts of group theory.Rings: Some basic concepts, Algebra over fields, ideals, Minimal, Maximal & prime ideals, PID and UFD, Euclidean domain, Polynomial rings. Modules : Definition of modules, properties of modules, sub modules, linear sum of two sub modules, direct sum of sub modules , homomorphism of modules, kernel of a homomorphism, cyclic modules.

Unit 5 Vector space: Review of Basic Concepts. Field: Extension field, Algebraic and Transcendental Extension field, roots of Polynomial, finite field.

ASSESSMENT

1. Internal Assessment for continuous evaluation, mid-term tests, tutorials, class performance, etc. (30%).
2. End semester Theory Exam (70%)

TEXT BOOKS RECOMMENDED

1. Herstein, I.N, Topics in Algebra, VikasPublications, Delhi-6, 1969.
2.SwapanK.Sarkar, ATextBook of Discrete Mathematics, S. Chand &Company Ltd., N Delhi,2003.
3.S. Lipschutz M. Lipson, Schaum'sOutline of Theory and Problems of Discrete Mathematics,2nd edition Tata McGraw Hill Publishing Company Ltd., NewDelhi,1997

REFERENCE BOOKS

1. Artin Michael, Algebra, Pearson Education Inc., 2007.
2. S.A.Wiitala, Discrete Mathematics, A Unified Approach, McGraw Hill Company, Singapore, 1987.

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE
M.Sc. I Semester
MA 94109: ORDINARY AND PARTIAL DIFFRENTIAL EQUATIONS

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
T	P	TU	T	P	TU	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
4	--	--	4	--	--	30	70	--	--	100

COURSE OBJECTIVE

To introduce the concept of Ordinary Differential Equations, Partial Differential Equationsand their applications.

COURSE OUTCOMES

After completion of the course, students are able to

- solve the problems based on existence and uniqueness of solutions of an initial value problem of first order using the concept of Lipschitz condition.
- understand detailed concepts of existence and uniqueness of solutions of an initial value problem of n-th order linear differential equations. Also they will be able to apply Wronskian and its properties to analyze linear dependence of solutions.
- classify PDE and solve their canonical form.
- apply and solve PDE in various coordinate systems using the method ofseparationof variables.
- understand the concept of Green's function and its applications in solving Laplace, Wave equation and Helmholtz theorem.

COURSE CONTENTS

THEORY

Unit 1 Theory of Ordinary Differential Equation: Initial and Boundary Value Problems, Picard's Iterations, Lipschitz conditions, Sufficient conditions for being Lipschitzian in terms of partial derivatives, Examples of Lipschitzian and Non-Lipschitzian functions, Picard's Theorem for local existence and uniqueness of solutions of an initial value problem of first order which is solved for the derivative, examples of problems without solutions and of equations where Picard's iterations do not converge .

Unit 2 Theory of Ordinary Differential Equation: Existence & Uniqueness for Ordinary Differential Equation, Wronskian and Linear independence, Initial value problem for nth order differential equation, Linear equations with variable coefficients, Lipschitz condition.

Unit 3 Fundamental concepts of partial differential equation, Elliptic differential Equations, Parabolic Differential equations, Hyperbolic Differential Equations.

Unit 4 Method of separation of variables: Laplace, Diffusion and Wave equations in Cartesian, cylindrical and spherical polar coordinates, Boundary value problems for transverse vibrations of strings and heat diffusion in a finite rod, Classification of linear integral equations, Relation between differential and integral equation.

Unit 5 Green's Functions: Introduction, Green's Function for Laplace Equation, Green's Function for the Wave Equation-Helmholtz Theorem.

ASSESSMENT

1. Internal Assessment for continuous evaluation, mid-term tests, tutorials, class performance, etc. (30%).
2. End semester Theory Exam (70%)

TEXT BOOKS RECOMMENDED

1. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall of India, New Delhi, 1968.

2. ZafarAhsan, Differential Equations and their Application, Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.

REFERENCE BOOKS

1. Sankara Rao, K., Introduction to Partial Differential Equations, Prentice Hall of India Pvt. Ltd., New Delhi ,1997.
2. Friedrich Sauvigny,Partial Differential Equations, Springer London Heidelberg 2006.
3. I.N. Sneddon: Elements of Partial Differential Equations, McGraw-Hill Pub.,1957.
4. T. Amaranath: An Elementary Course in Partial Differential Equations, Narosa Pub. 2005.

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE
M.Sc. II Semester
MA 94205: MATHEMATICAL THEORY OF COMPUTATION

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
T	P	TU	T	P	TU	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
4	--	--	4	--	--	30	70	--	--	100

COURSE OBJECTIVE

To introduce the concepts of mathematical foundations of computation using automata theory, formal languages and grammar, turing machine with their complexity and computability.

COURSE OUTCOMES

After completion of the course, students are able to

- acquire the knowledge of basic concepts of set theory, graphs, preposition and predicate calculus.
- understand the concept of finite automata and its different types together with formal languages and grammars, regular grammar and regular languages.
- understand the fundamental concepts and properties of context-free languages , context-free grammar and solve various problems by applying normal form techniques for context free-grammars.
- analyze and design Pushdown Automata machine for given CF language.
- acquire the knowledge of basic concepts of Turing machines and solve computational problems regarding their computability and complexity.

COURSE CONTENTS

THEORY

Unit 1 Introduction: Review of sets, Relations and Functions, Graphs, Trees, Principal of Induction, Languages and Grammers-Fundamental Concepts, Preposition and Predicate Calculus.

Unit 2 Theory of Automata: Definition of Automata; Description of finite Automata-Deterministic finite Accepters (DFAs), Non-deterministic finite Accepters (NFAs),Regular expression, Regular Grammars and Languages, Properties of Regular Languages, Pumping Lemma for Regular Languages.

Unit 3 Context Free Languages: Context free-grammars and Derivation Trees, Parsing and ambiguity, Normal form for Context free-grammars -Chomsky and Greibach normal form, Pumping Lemma for Context Free languages,Properties of Context Free languages.

Unit 4 Pushdown Automata:Basic Definition of Pushdown Automata, Non Deterministic Pushdown Automata and Deterministic PushdownAutomata, Pushdown Automata and Context Free languages.

Unit 5 Turing Machines:Definition of a Turing Machine, Turing Machine as Language, Accepters, Turing's Thesis, Universal Turing Machine, Linear Bounded Automata, Computational complexity theory- P and NP Problems.

ASSESSMENT

1. Internal Assessment for continuous evaluation, mid-term tests, tutorials, class performance, etc. (30%).
2. End semester Theory Exam (70%)

TEXT BOOKS RECOMMENDED

1. Peter Linz, An Introduction to Formal Languages and Automata, 2nd Edition, Narosa Publishing House,1997.
2. K.L.P.Mishra, N.Chandrasekaran, Theory of Computer Science Automata, Language and Computation, 3rd Edition, Prentice Hall of India,2007.

REFERENCE BOOKS

1.H. R. Lewis and C.H.Papadimitriu , Elements of the theory of Computations, Prentice Hall of India Pvt. Ltd., New Delhi;1999.
2.Robert N. Moll , Michael A. Arbib , A.J.Kfoury , An introduction to formal language theory , Springer Verlag, New York,1988.
3.MichaelSipser, Introduction to the Theory of Computations, PWS Publishing Company Boston,1997.

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE
M.Sc. II Semester
MA 94206: DATA PROCESSING AND COMPUTATION

PERIOD PER WEEK			CREDITS			MAXIMUM MARKS				
T	P	TU	T	P	TU	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
4	--	--	4	--	--	30	70	--	--	100

COURSE OBJECTIVE

To introduce the basic concepts of Database System and Architecture, various Data Models, Structured Query Language (SQL), Normalization theory and Transaction Processing.

COURSE OUTCOMES

After completion of the course, students are able to

- acquire the knowledge of basic concepts of various data model used in database design.
- understandER modeling, relational modeling and apply relational database theory to *describe* relational algebra expression.
- write SQL queries to retrieve information from databases and understand the concepts and importance of indexing, view and sequences.
- acquire the knowledge of basic concepts of Normalization theory, network and hierarchical data models.
- understandthe concept of transaction processing, concurrency control and recovery system in database.

COURSECONTENTS

Unit-I Database System Concepts and Architecture: Categories of Data Models, Schema, Instances and Database State, Database Architecture, Data Independence and Database Languages.

Unit-II Data Modeling using Entity-Relationship Model, Relational Model, Relational Algebra.

Unit-III Structured Query languages (SQL): Data Types, Basic Queries in SQL, Insert, Retrieve, Delete and Update data using SQL, Types of Data Constraints, Computation on Table Data, Grouping data from Tables, Indexing, Sequences and VIEWS in SQL.

Unit-IV Concepts of Network and Hierarchical Data Models, Normalization Theory: Functional dependency, First Normal form, Second Normal form, Third Normal form, Boyce-Codd Normal form, Multivalued dependency and Fourth Normal form, Join dependency and First Normal form.

Unit-V Introduction to Transaction Processing, Characterizing Schedules, Concurrency Control Techniques, Database Recovery Concepts and Techniques.

ASSESSMENT

1. Internal Assessment for continuous evaluation, mid-term tests, seminar, tutorials, class performance, etc.(30%)
2. End Semester Theory Exam(70%)

TEXT BOOKS RECOMMENDED

1. RamezElmasri and Shamkant B. Navathe, Fundamentals of Database Systems, 7th Edition, Pearson,2016.
2. H.F Korth, A. Silberchatz and S. Sudarshan, Database Systems Concepts,6th Edition McGraw Hill, 2010.

REFERENCE BOOKS

1. G.K.Gupta , Database Management Systems, Tata McGraw Hill Education Private Limited, New Delhi, 2011.
2. Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems McGraw Hill Education Private Limited3rd Edition, 2014.

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE
M.Sc. II Semester
MA 94207: OPERATIONS RESEARCH

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
T	P	TU	T	P	TU	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
4	--	--	4	--	--	30	70	--	--	100

COURSE OBJECTIVE

To introduce operation research for solving assignment, transportation, sequencing, Dynamic and Non-Linear Programming problems.

COURSE OUTCOMES

After completion of the course, students are able to

- formulate and solve linear programming problems using graphical, Simplex, dual Simplex and Big M methods.
- solve Assignment, Transportation and Game Theory problems.
- apply sequencing and scheduling problems
- understand basic concepts related to information theory and its applications
- understand and apply dynamic programming problems and non-linear programming problems

COURSE CONTENTS

THEORY

Unit 1 Introduction to Operations research, Mathematical formation of Linear Programming problems, Graphical solution as two phase method, Linear Programming problems, Simplex method, Big M method, Duality in linear programming, Dual simplex method, degeneracy.

Unit 2 Assignment and Transportation problems, Game theory: Simple and mixed strategy game, two persons zero sum games, Dominance property.

Unit 3 Sequencing and scheduling: Sequencing problem with n jobs and m machines, optimal sequence algorithm, Critical path determination by CPM and PERT methods.

Unit 4 Information Theory: Basics ideas, Communication system, Noisy and noiseless channel, Channel matrix, Mathematical Definition of information, Measure of uncertainty and properties of entropy function, Channel capacity, efficiency and redundancy encoding, Shannon Fano method.

Unit 5 Dynamic and Non-linear programming: Concept of dynamic programming,decision tree and Bellman's principle of optimality, Solution of problem with finite number of stages, minimum path problem. Lagrangian method, Kuhn- Tucker conditions, Quadratic programming.

ASSESSMENT

1. Internal Assessment for continuous evaluation, mid-term tests, tutorials, class performance, etc. (30%).
2. End semester Theory Exam (70%)

TEXT BOOKS RECOMMENDED

1. TahaH. A, Operations Research: An Introduction, McMillian Co., NewYork.
2. Gupta, KantiSwaroop, Gupta P.K. and Manmohan, Operations Research, Sultan Chand and Sons, NewDelhi.

REFERENCE BOOKS

1. R. Pannerselvam, Operations Research, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
2. S.D. Sharma, Operations Research, KedarNath&Co.Meerut.

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE
M.Sc. II Semester
MA 94208: REAL AND COMPLEX ANAYSILS

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
T	P	TU	T	P	TU	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
4	--	--	4	--	--	30	70	--	--	100

COURSE OBJECTIVE

To introduce the concept of Lebesgue measure theory, FourierSeries, Real and Complex Analysis.

COURSE OUTCOMES

After completion of the course, students are able to

- understand the concept of measurable sets, measurable functions and Lebesgue integration.
- understand Fourier series with its convergent criteria and consequences of Riemann-Lebesgue theorem.
- understand the concept of analytic functions, conformal mappings and their properties, application of mean value property, Poisson and Schwartz's theorem.
- solve the integration of function of complex variable using Cauchy's theorem and integral formula.
- understand the concept of Cauchy residue theorem and its application.

COURSE CONTENTS

THEORY

Unit 1 Measure theory, function of bounded variation, measurable non-measurable sets, Borel sets, measurable functions, Lebesgue integral for bounded function over a set of finite measure, Lebesgue integral for unbounded function, theorems on convergence in measure, Lebsegue class L^P.

Unit 2 Fourier series: Convergent criteria of Fourier series, Convergent problem, Dirichlet's Conditions, Riemann-Lebesgue Theorem and its Consequences and Fourier analysis.

Unit 3 Concept of analytic function, C-R equations, Conjugate function, harmonic functions, the mean value property, Poisson's formula, Schwarz's theorem and the reflection principle. Conformality, areas and closed curves analytic function in regions, Conformalmapping, length and area, linear transformation, the linear groups, cross-ratio symmetry and oriented circles, use of level surface.

Unit 4 Complex Integration: Line integrals, Rectifiable arcs, Cauchy's theorem for a rectangle, Cauchy's theorem for a circular disk. The index of a point with respect to a closed curve, Cauchy's integral formula.

Unit 5 The general form of Cauchy's theorem and calculus of residues: chains and cycles, simple connectivity, Exact differentials in simply connected regions, Residuetheorem,the argument principle, Branch points.

ASSESSMENT

1. Internal Assessment for continuous evaluation, mid-term tests, tutorials, class performance, etc. (30%).
2. End semester Theory Exam (70%)

TEXT BOOKS RECOMMENDED

1. AlhforsL.V., Complex Analysis (3rd Edition), McGrawHill,Inc.Singapore,1979.
2.Royden H.L., Real Analysis (3rd Edition), Collier Macmillan International, New York, 1987.

REFERENCE BOOKS

1.SE.C.Titchmarsh, The Theory of Functions,2nd edition, Oxford University Press,London,1939.
2.SinghBijendra ,KaranjgaokarVarsha, Chandel R.S. , Complex Analysis , GauraPustakSadan ,Agra.

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE
M.Sc. III Semester
MA 94303: FUNCTIONAL ANALYSIS AND INTEGRAL EQUATIONS

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
T	P	TU	T	P	TU	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
4	--	--	4	--	--	30	70	--	--	100

COURSE OBJECTIVE

To introduce the concepts of Topological space, Normed linear space, Hilbert space, Finite dimensional spectral theory and Integral Equations.

COURSE OUTCOMES

After completion of the course, students are able to

- acquire the knowledge of continuous functions, homeomorphisms, compact spaces, connected spaces and separation axioms over various topological spaces.
- understand the proof and application of some famous theorems as; Hahn-Banach theorem, closed graph theorem and Uniform bounded principle in functional analysis.
- understand the concept of Hilbert space and its properties, application of Bessel's inequality, Riesz representation theorem.
- understand the concept of various operators with their properties, application of spectral theorems and fixed-point theory.
- solve the problems on integral equation and use of green's function in boundary value problems.

COURSE CONTENTS

THEORY

Unit 1 Topological Space: Definition, Open Set, Closed Set, Continuous mapping, Homomorphism, Separation axioms, Connectedness and Compactness.

Unit 2 Normed Linear Spaces**:** Branch space, Quotient space, continuous linear transformation, Hahn Banach theorem and its consequences, Conjugate space and separability. The Natural imbedding of the normed linear closed graph theorem, The uniform boundedness principle.

Unit 3 Hilbert Spaces: Definition and some of its properties, orthonormal complements, the projection theorem, orthonormal sets. The Bessel's inequality, Fourier expansion and Parseval's equation (without proof) Riesz representation theorem.

Unit 4 Finite Dimensional Spectral Theory: Basic preliminary definitions of adjoint of an operator, self-adjoint operators, normal and unitary operators, And their properties. Projections, the spectral theorem, fixed-point theory and its applications.

Unit 5 Integral Equations: Preliminary concepts, formulation of integral equations and Classification of linear integral equations. Integral differential equations, conversions of ordinary differential equations to integral equations. Solutions of integral equations with separable kernels. Characteristics number and eigen functions, Fredholm determinant method. Construction of Green's functions and its use in solving the boundary value problems, reductions of B.V. problems to integral equations. Resolvantkernal of the integral equations, method of successive approximation, convolution type kernels integral transform methods.

ASSESSMENT

1. Internal Assessment for continuous evaluation, mid-term tests, tutorials, class performance, etc. (30%).
2. End semester Theory Exam (70%)

TEXT BOOKS RECOMMENDED

1. B.k. Lahiri , Elements of functional analysis, The world press Pvt. Ltd. , Calcutta,1982.
2.Karsnov M., Kiselv A., MakAernkog, Problems and Exercise in Integral Equations.

REFERENCE BOOKS

1.A.H. Siddhiqui, Functional Analysis. With Applications, Tata McGraw HillPublishing Company Ltd., New Delhi, 1986.
2. G. F. Simmons, "Introduction to Topology and Modern Analysis," McGraw Hill Book Company, Inc., New York,1963.

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE
M.Sc. III Semester
MA 94304: OBJECT ORIENTED PROGRAMMING SYSTEMS

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
T	P	TU	T	P	TU	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
4	--	--	4	--	--	30	70	--	--	100

COURSE OBJECTIVE

To develop programming skills, learn the basic concepts of OOPS, object-oriented program analysis, design and testing.

COURSE OUTCOMES

After completion of the course, students are able to

- understand the basic concepts and importance of object oriented programming system, difference between structured oriented and object oriented programming features.
- applythe concepts of objects, classes, function overloading, operator overloading for developing programs.
- understand the concepts of inheritance, polymorphism and its different types.
- investigate principles and different methods of object-oriented analysis and design.
- acquiretheknowledge of basic aspects of object-oriented program testing with its different methods, techniques of Rapid Prototyping and UML.

COURSE CONTENTS

THEORY

Unit 1 Introduction to Object Oriented Programming fundamentals, Comparison with procedural programming, Basic concepts of object oriented programming, Merits and demerits of OO methodology, Elements of the object model.

Unit 2 Object oriented concepts: Concepts of objects and classes, attributes and methods, Access modifiers, static member of a class, Instances, Message passing, Constructors and destructor, data abstraction, encapsulation and data hiding.

Unit 3 Inheritance: purpose and its types, Polymorphism: Introduction, Method of overriding and overloading, compile time and run time polymorphism.

Unit 4 Introduction to object oriented analysis and design: Design concepts, use cases, class diagrams, State Transition diagrams, object diagrams.

Unit 5 Rapid prototyping: Overview, method process and techniques, object oriented testing: Concepts, methods, UML pattern.

ASSESSMENT

1. Internal Assessment for continuous evaluation, mid-term tests, tutorials, class performance, etc. (30%).
2. End semester Theory Exam (70%)

TEXT BOOKS RECOMMENDED

1. Grady Booch, Objected Oriented Analysis and Design with Applications, Addison Wesley, 2nd Edition California 1994.
2. Balaguruswamy, Object Oriented Programming using C++,TataMc-Grawpublication, 1995.

REFERENCE BOOKS

1. James Martin, Principles of Object Oriented Analysis and Design, Prentice Hall.
2. Timothy A. Budd, An Introduction to Object Oriented Programming, 3rdEdition,PearsonEducation,2008.

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE
M.Sc. III Semester
MA94353: REGRESSION ANALYSIS FOR DATA SCIENCE

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
T	P	Tu	T	P	Tu	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
4	--	--	4	--	--	30	70	--	--	100

COURSE OBJECTIVES

The objective of the course is to make the students understand the concepts of statistic, sampling, hypotheses, regression analysis and multivariate data analysis.

COURSE OUTCOMES

On completion of the course, students will be able to

- understand the concept of statistic to solve the related problems
- describe the hypotheses and perform the large and small sample test
- develop in-depth understanding of the linear and nonlinear regression model
- perform the regression modeling and model selection techniques
- Demonstrate the knowledge and skill of multivariate model, methods and techniques for data analysis

COURSE CONTENTS

THEORY

Unit I Statistics: Concepts of statistical population and sample, measures of central tendency, measures of dispersion, Kurtosis and Skewness.

Unit II Hypothesis Testing: Introduction-Types of errors, critical region, procedure of testing hypothesis - Large sample tests- Z test for Single Proportion, Difference of Proportion, mean and difference of means, small sample tests- Student's t-test, F-test and Chi-square test.

Unit III Simple Regression Analysis: correlation, multiple correlation, partial correlation, introduction to linear and non-linear model, ordinary least square methods, fitting a linear trend, simple linear regression, validating simple regression model using t, F and p test, Developing confidence interval.

Unit IV Multiple Regression Analysis**:** Concept of Multiple regression model to describe a linear relationship, Assessing the fit of the regression line, inferences from multiple regression analysis, problem of overfitting of a model, comparing two regression model, prediction with multiple regression equation.

Unit V Multivariate Data Analysis: Multivariate data and their diagrammatic representation, Exploratory multivariate data analysis, sample mean vector, sample dispersion matrix, sample correlation matrix, graphical representation, means, variances, co-variances, correlations of linear transforms, six step approach to multivariate model building, Introduction to multivariate linear regression, logistic regression, principal component analysis, factor analysis, cluster analysis, canonical analysis and canonical variables, structured equation modeling (SEM).

ASSESSMENT

1. Internal Assessment for continuous evaluation, mid-term tests, tutorials, class performance, etc. (30%).
2. End semester Theory Exam (70%).

TEXT BOOKS RECOMMENDED

1. Manoj Kumar Srivastava and Namita Srivastava, Statistical Inference – Testing of Hypotheses, Prentice Hall of India, 2014.
2. Norman R. Draper, Harry Smith; Applied Regression Analysis, WILEY India Pvt. Ltd. New Delhi; Third Edition, 2015.

REFERENCE BOOKS

1. Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining, Introduction to Linear Regression Analysis, Third Ed., Wiley India Pvt. Ltd., 2016.
2. Johnson, R A., Wichern, D. W., Applied Multivariate Statistical Analysis, Sixth Ed., PHI learning Pvt., Ltd., 2013.

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE

M.Sc. III Semester
Elective – II
MA94372: MATHEMATICAL MODELLINGAND APPLICATIONS

PERIOD PER WEEK			CREDITS			MAXIMUM MARKS				
T	P	TU	T	P	TU	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
4	--	--	4	--	--	30	70	--	--	100

Prerequisites: Basics of algebra, differential equation, difference equations and graphs, fuzzy logic.

COURSE OBJECTIVE

To introduce knowledge of basic concepts and core techniques behind mathematical modelling and develop basic ability to quantify certain phenomena associated with the real-world systems in mathematical frame work.

COURSE OUTCOMES

After Completion of the course, students are able to

- acquire knowledge of basic concepts of mathematical modelling, formulation of mathematical models and their solutions.
- construct and solve different linear and non-linear mathematical models using ordinary differential equations
- formulate mathematical models using differential equations and find their solutions
- develop various mathematical models through graph theoretic techniques
- solve mathematical models using various ooptimization techniques

COURSE CONTENTS

UNIT I Concept of Models: Types of models- Iconic, analogue and symbolic models, Classification of models, Model formulation and Solution, Classes of mathematical models and examples of each, Features of good models, Benefits of using mathematical models, Characteristics and limitations of mathematical modelling.

UNIT II Mathematical Modelling through Ordinary Differential Equations: Linear Growth and Decay Models, Non-Linear Growth and Decay Models, Compartment Models, Dynamic problems, Geometrical problems. Population Dynamics, Epidemics, Compartment Models. Mathematical Modelling through Linear Differential Equations of Second Order: Planetary Motions, Circular Motion and Motion of Satellites.

UNIT III Mathematical Modelling through Difference Equations: Simple Models – Basic Theory of Linear Difference Equations with Constant Coefficients, Models based on linear difference equations, Cobweb model, Harrod Domar growth model, Consumption model, Samuelson's multiplier, Accelerator model.

UNIT IV Mathematical Modelling through Graphs: Solutions that can be Modelled Through Graphs–Mathematical Modelling in Terms of Directed Graphs, Signed Graphs, Weighted Digraphs and Unoriented Graphs.

UNIT V Mathematical Modelling through Linear Programming, Fuzzy Linear Programming and Dynamic programming: Solution of different industry oriented problems.

ASSESSMENT

1. Internal Assessment for continuous evaluation, mid-term tests, seminars, tutorials, class performance etc. (30%).
2. End semester Theory Exam(70%)

TEXT BOOKS RECOMMENDED

1. J.N. Kapur, Mathematical Modelling, New Age International, 1988.
2. Jerry Banks, John S. Carson II, Barry L Nelson, David M. Nichol, Discrete Event System Simulation, Pearson Publication, Fourth Edition, 2005.

REFERENCE BOOKS

1. Edward A. Bender, Introduction to Mathematical Modelling, Dover Publications, 1st Edition 2000.
2. Seyed Hadi Nasseri, Ali Ebrahimnejad Bing-Yuan Cao, Fuzzy Linear Programming: Solution Techniques and Applications, Springer; 1st ed. 2019.