

**SYLLABUS FOR POST GRADUATE COURSE
MATHEMATICS
(With effect from 2023-2024)**

**Under Choice Based Credit System with
Semester Pattern and Open Elective**



**DEPARTMENT OF MATHEMATICS
Dharanidhar University
(Keonjhar, 758001)**

P.G. Department of Mathematics
Dharanidhar University, Keonjhar
M.Sc / M.A Mathematics-Revised Course Structure under
CBCS and Open Elective

SEM-I	Course Code	Course Title	Credit	Exam hrs	Marks		Total
					Internal	Semester	
	MATHC-101	Measure Theory and Integration	04	03	20	80	100
	MATHC - 102	Complex Analysis	04	03	20	80	100
	MATHC -103	Numerical Analysis	04	03	20	80	100
	MATHC -104	Differential Equation	04	03	20	80	100
	MATHP -105	Data processing and Numerical Computing Lap	04	06	--	100	100
	Total		20		80	420	500
SEM-II	MATHC -201	Numerical Optimization or Operation Research	04	03	20	80	100
	MATHC - 202	Topology	04	03	20	80	100
	MATHC - 203	Discrete Mathematics	04	03	20	80	100
	MATHC -204	Linear Algebra	04	03	20	80	100
	MATHP - 205	Programming on C++ / Python	04	06	--	100	100
	MATH(VAC) - 206	Matrix Algebra	NO CREDIT				GRADE
	Total		20		100	500	500
SEM-III	MATHC -301	Graph Theory	04	03	20	80	100
	MATHC -302	Functional Analysis	04	03	20	80	100
	MATHC -303	Abstract Algebra	04	03	20	80	100
	MATH(OE)-304	Fuzzy Logic & Set Theory -I / A Design and Analysis of Algorithm - I	04	03	20	80	100
	MATHC -305	Seminar Presentation	04	06	---	100	100
	MATH(VAC) - 306	Mathematical Modelling	NO CREDIT				GRADE
	Total		20		80	420	500
SEM-IV	MATHC -401	Probability and Statistics	04	03	20	80	100
	MATHC -402	Number Theory	04	03	20	80	100
	MATHC -403	Real Analysis	04	03	20	80	100
	MATH(OE) - 404	Fuzzy Logic & Set Theory -II / A Design and Analysis of Algorithm - II	04	03	20	80	100
	MATHC -405	Dissertation, Presentation and Viva-Voce	04	06	----	100	100
	Total		20		60	340	500
	Grand Total		80				2000

Program Outcome:

- Students will be able to enhance the knowledge.
- They will get employment opportunities in various field like administration, academic, research, banking, finance etc
- They will get opportunities for further studies and research.
- They can get prospect to join on research work and make career therein.
- They can be able to get opportunity to improve soft skills and personality.

Program Specific Outcome:

- Students will understand real analysis, complex analysis, graph theory, topology, algebra, analysis and design of algorithms, operations research, fuzzy logic, etc and can be able to apply in different field of engineering and research.
- They will be able to compete in the various examination like NET, GATE, etc.
- They can use mathematical theorems, tools and techniques in other interdisciplinary field.
- They can be able to develop algorithms in different field like medical diagnosis, engineering, etc.
- An open elective is introduced in this course for the students of different departments. Students from other departments in Semester-II, can opt this open elective: **Basic Probability Theory and Statistics**, which will be beneficial to them in different field.
- Two **elective papers** are introduced in Sem-III and IV. Students can choose any one elective paper.

SEMESTER-I
MATHC -101 MEASURE THEORY

Time: 3 Hrs

FM:100 (80+20)

Unit-1: Uniform convergence and differentiation: Equicontinuity, Ascoli's Theorem, Weierstrass approximation

Unit-II: Lebesgue Measure: Measurable sets of Measure Zero, Lebesgue Outer Measure, The Sigma-Algebra of Lebesgue Measurable sets, Borel Set, Outer and Inner Approximation of Lebesgue Measurable Sets.

Unit-III: Sequential Pointwise Limits and Simple Approximation, Littlewood's Three Principles, Egoroff's Theorem and Lusin's Theorem.

Unit-IV: Lebesgue Integration: The Riemann Integral, The Lebesgue Integral of a bounded Measurable Function over a Set of Finite Measure, The bounded Convergence Theorem, The Lebesgue Integral of a Measurable Nonnegative Function, Fatou's Lemma, The Monotone Convergence Theorem.

Books for Recommended:

Royden H. L. Real Analysis, Macmillan

Books for Reference:

1. De Barra G. Measure Theory and Integration, New Age International
2. Halmos P. R. Measure Theory, Graduate Text in Mathematics, Springer-Verlag
3. Cohn D. L. Measure Theory, Springer
4. Principle of Real Analysis by J.L. Rudin

MATHC -102 COMPLEX ANALYSIS

Full Marks: 100(80+20)

Time: 3 Hours

Course Outcome: The student will understand the concept of complex numbers, complex plane, complex integration etc. They can be acquainted with cauchy integral theorem, analytic function, liouville's theorem. Students will be able to understand the basic concept of power series, taylor's and maclaurin's series, morera's theorem. They can also be able to solve the problems of power series, taylor's series. They will be able to do convergence test on given series and will understand laurent series, residue integration etc.

Contents

Unit-I

Complex Numbers and Functions: Complex Numbers, Complex Plane, Polar form of Complex Numbers, Powers and Roots, Analytic Function, Cauchy Riemann Equations, Laplace's Equation, Exponential Function, Trigonometric and Hyperbolic Functions, Logarithmic Function.

Unit-II

Complex Integration: Line Integral in the Complex Plane, Cauchy Integral Theorem, Cauchy

Integral Formula, Cauchy Goursat's Theorem, Derivatives of Analytic Function, Morera's Theorem, Maximum Moduli of Functions, Liouville's Theorem and Fundamental Theorems of Algebra.

Unit-III

Power Series, Taylor's Series: Sequence, Series, Convergence Test, Power Series, Functions Given by Power Series, Taylor's and Maclaurin Series, Uniform Convergence, Laurent Series and Residue Integration: Laurent Series.

Unit-IV

Laurent Series and Residue Integration: Singularities and Zeros, Residue Integration Method, Residue Integration of Real Integral, Argument Principle, Conformal Mapping: Geometry of Analytic Function, Linear Fractional Transformation (Möbius Transformation), Special Linear Fractional Transformation.

Books Recommended

1. R. V. Churchill and J.W. Brown: Complex Variables and Applications (Fifth Edition, Mcgraw-Hill Publishing Company, 1990)
2. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley
3. Ahlfors L. V. Complex Analysis, Mcgraw Hill.

Books for Reference

1. J. B. Conway: Function of Complex Variable (Springer- Verlag, International Student Edition, Narasa Publishing House-1980).
2. W. Rudin: Real and complex analysis, McGraw-Hill Book Co

MATHC -103 NUMERICAL ANALYSIS

Full Marks: 100(80+20)

Time: 3 Hours

Unit-I: Solution of equations in one and two variables: Fixed point iteration method, Accelerate on of convergence, Zeros of polynomials and Muller's method, fixed points for functions of several variables, Newton's method.

Unit-II: Interpolation: Hermite interpolation, Cubic spline interpolation, parametric curves, Hermite, Bazier and B

Unit-III: Least square approximation, Discrete L.S. approximation, Orthogonal polynomials, Chebyshev polynomials and economization, rational approximation. Numerical integration: Elements, Composite integration, Romberg integration, Gauss quadrature.

Unit-IV Approximation of multiple integrals: Product rules, Rules exact for monomials, Radon formula for approximation of integrals in two dimensions.

Books Recommended

1. Numerical Analysis (7th Edition) by R.L. Burden and J.D. Faires, (Books/Cole, Thomson learning)
2. Methods of Numerical Integration (4th Edition) by P.J. Davis and Rabinowitz (AP).

MATHC -104 DIFFERENTIAL EQUATIONS

Time: 3 Hours

Full Marks: 100(80+20)

Unit-1: Existence and Uniqueness of Solutions Lipschitz condition, Gronwall inequality, Successive approximations, Picard's theorem, Continuation and dependence on initial conditions, Existence of solutions in the large, Existence and uniqueness of solutions of systems, Fixed point method Systems of Linear Differential Equations nth order equation as a first order system, Systems of first order equations, Existence and uniqueness theorem, fundamental matrix, Non-homogeneous linear systems, Linear systems with constant coefficients.

Unit-II: Non-linear Differential Equations: Existence theorem, Extremal solutions, Upper and Lower solutions, Monotone Iterative method and method of quasi linearization. Stability of Linear and Nonlinear Systems: Critical points, Systems of equations with constant coefficients, Linear equations with constant coefficients, Lyapunov stability.

Unit-III: Boundary value problems for ordinary differential equations: Sturm-Liouville problem, Eigen value and eigen functions, Expansion in eigen functions, Green's function, Picard's theorem for boundary value problems. Series solution of Legendre and Bessel equations.

Unit-IVThe Laplace Equation: Boundary value problem for Laplace's equation, fundamental solution, Integral representation and mean value formula for harmonic functions, Green's function for Laplace's equation, Solution of the Dirichlet problem for a ball, solution by separation of variables, solution of Laplace's equation for a disc. The wave equation and its solution by the method of separation of variables, D'Alembert's solution of the wave equation, Solution of wave equation by Fourier transform method.

Books Recommended

1. S.D.Deo, V.Lakshmikantham and V.Raghavendra: Text Book of Ordinary Differential Equations, 2nd Edition, TMH. Chapters: 4(4.1-4.7), 5, 6(6.1-6.5), 7(7.5), 9(9.1-9.5).
2. J.Sinha Roy and S.Padhy: A Course on Ordinary and Partial Differential Equations, Kalyani Publishers. Chapters: 10, 15, 16 and 17

MATHP -105
**Practical: DATA PROCESSING & NUMERICAL
COMPUTING LAB**

Full Marks: 100

Time: 6 Hours

Numerical Computation using C++.

- (1) Basic elements of C++, Control structures, Loops, I/O concepts, Arrays, Functions.
- (2) Implementation of the following by using C++.
 - (i) Solution of the equation $f(x) = 0$ by (a) Fixed point iteration method (b) Newton-Raphson method.
 - (ii) Solving a tridiagonal system of equations. (iii) Solving a system of linear equations by (a) Matrix Factorisation Method. (b) Gauss-Seidel Method.
 - (iv) Finding the inverse of a matrix.
 - (v) Finding least square polynomial fit to a given data.
 - (vi) Approximating a definite integral by (a) Newton-Cotes Rules (b) Gauss-Legendre Rules. (vii) Solution of an initial value problem by Runge-Kutta Method of order 4.
- (viii) Determination of eigen values of a matrix by Power method/QR method.

Books Recommended

- i. E. Balagurusamy: Object-Oriented Programming with C++, 2nd edition, Tata McGraw- Hill Publishing Company Ltd

Books for Reference:

- i. M.A Welss: Data Structure and Algorithm Analysis in C++, Reason Education, 2000
- ii. S.B.Lippoman and J.Lamyoie: C++ primer- klesley, 1998

SEMESTER-II

MATHC -201 NUMERICAL OPTIMIZATION

Time: 3 Hours

Full Marks: 100(80+20)

Unit-I: One Dimensional Optimization: Introduction, Function comparison methods, Polynomial Interpolation, Iterative methods.

Unit-II: Gradient Based Optimization Methods(I): Calculus on R_n , Method of Steepest Descent, Conjugate Gradient Method, The Generalized reduced Gradient Method, Gradient Projection Method. method),

Unit-III: Gradient Based Optimization Methods(II): Newton type Methods(Newton's method, Marquardt's Quasi Newton Methods. Linear Programming: Convex Analysis, Simplex Method, Two Phase Simplex Method, Duality Theory, Dual Simplex Method.

Unit-IV: Constrained Optimization Methods: Lagrange Multipliers, Kuhn-Tucker Conditions, Convex Optimization, Penalty function techniques, method of Multiplier, Linearly Constrained problems- Cutting plane Method.

N.B.-The mid-semester examinations (Marks:30) will be a programming assignment followed by a viva-voce test.

Books Recommended

1. M.C. Joshi and K.M. Moudgalya-Optimization: Theory and Practice, Narosa Publishing House, 2004.
2. J.A. Snyman Practical Mathematical Optimization, Springer Sciences, 2005

OR

OPERATION RESEARCH

Times- 3 Hrs

Full Mark: 100(80+20)

Unit-I

Introduction to LPP, Simplex Method, Two Phase and Big M Simplex Method. Integer Programming: Fractional Cut Method-All Integer, Fractional Cut Method-Mixed Integer, Branch and Bound Method. Revised Simplex Method.

Unit-II

Duality in Linear Programming: Definition of Primal and Dual, Duality and Simplex Method The Dual Simplex Method. Transportation Problem: Introduction, Solution of TP (North- West Corner Method, Least-Cost Method, Vogel's Approximation Method), Test for Optimality, Degeneracy in TP. Transportation Algorithm (MODI Method). Assignment Problem, The Travelling Salesman Problem.

Unit-III

Sequencing Problem: Introduction, Processing N Jobs Through Two Machines, Processing Two Jobs Through K Machines. Games & Strategies: Introduction, Two-Person Zero-Sum Games, The Maximin-Minimax Principle, Games without Saddle Points: Mixed Strategies, Dominance Property.

Unit-IV

Network Scheduling By PERT/CPM:Introduction, Network and Basic Components, Logical Sequencing, Rules of Network Construction, Critical Path Analysis. Non-Linear Programming Methods: Introduction, General Non-Linear Programming Problem, Constrained Optimization with Equality Constraints.

Books Recommended

1. KantiSwarup, P.K. Gupta, Man Mohan: Operations Research, Sultan Chand & Sons Publishers, New Delhi
2. M.E. Joshi And K.M. Moudgalya- Optimization Theory and Practice, Narosa Publishing House-2001
3. J.A. Suyman- Practical Mathematical Optimization. Springer Sciences-2005
4. S.D Sharma: Operations Research, Kedarnath Ram Nath&Co Publishers, Meerut

MATHC-202 TOPOLOGY

Time: 3 Hours

Full Marks: 100(80+20)

Unit-I

Infinite Sets, The Axiom of Choice, Well-Ordered Sets. Topological Spaces, Basis and Sub Basis for a Topology, The Order, Product and Subspace Topology, Closed Sets & Limit Points.

Unit-II

Continuous Functions and Homomorphism, Metric Topology, Product Topology. Connected Spaces, Connected Sets in Real Line, Components and Local Connectedness.

Unit-III

Compact Spaces, Compact Sets in Real Line, Limit Point Compactness, Local Compactness, The Countability Axioms.

Unit-IV

The Separation Axioms, Normal Spaces, The Urysohn Lemma, The Urysohnmetrization Theorem, The Tychonoff Theorem.

Books Recommended

- 1.J.R. Munkress: Topology, A First Course (Prentice Hill of India, Pvt.Ltd, 2000)
Chapter-1 (1.9, 1.10), 2 (2.1 To 2.10), 3, 4 (4.1 To 4.4), 5.

Books For Reference

1. K.D Joshi: Introduction to General Topology, Wiley Easter Ltd. 1983
2. W.J. Pervin: Foundation of General Topology, Academic Press, 1964
3. S.Nanda And S.Nanda: General Topology, Mac-Millan, India

PAPER : MATHC-203

Discrete Mathematics

Time: 3 Hrs

FM: 100 (80+20)

Unit-1 Fundamentals of logic, Logical inferences, Methods of proof of logical inferences, First order logic, Inference for quantified propositions, Order relations, Posets, Lattices, Enumerations, Hasse diagrams, Path and closure, Discrete graphs, and adjacency matrices.

Unit-II Boolean algebra, Boolean functions, Switching mechanisms, Canonical forms, Minterms, Minimization of Boolean functions.

Unit-III: Graphs: Basic concepts, Isomorphic graphs, Sub-graphs, Trees and properties, Spanning trees, Directed trees and Binary trees.

Unit-IV: Planar graphs, Euler formula, Multi graphs and Euler Circuits, Hamiltonian graphs, Chromatic. Network flows: Graphs as models of flow of commodities, flows, Maximal flows, and minimal cuts, Max-flow Min-cut theorem.

Book Recommended

1. J.L. Mott, A. Kendel and T.P. Baker: Discrete mathematics for Computer Scientists and Mathematicians, Chapters-1(1.5-1.9), IV(4.4-4.7), V(5.1-5.11), VI(6.1-6.5), VII(7.1-7.4).

MATHC -204
LINEAR ALGEBRA

Time: 3 Hours

Full Marks: 100(80+20)

Unit-1

Vector Spaces: Elementary Basic Concepts, Linear Independence and Bases, Dual Spaces, Inner Product Spaces.

Unit-II

Linear Transformations: The Algebra of Linear Transformation, Characteristic Roots, Matrices, Eigen Values, Eigen Vectors, Rank, Nullity and Kernel of Matrix.

Unit-III

Canonical Forms: Triangular Form, Nilpotent Transformation, Introduction to Rational Canonical and Jordan Canonical Form, Trace and Transpose, Consistency of Linear System of Equations, Determinant and Related Theorems.

Unit-IV

Gauss Jordan Method for finding the Inverse. Caley Hamilton Theorem, Hermitian, Unitary and Normal Transformation, Complex Matrices: Conjugate of a Matrix, Hermitian and Skew Hermitian Matrices, Unitary Matrix.

Books Recommended:

1. I.N. Herstein, Topics in Algebra, Wiley

Books For Reference:

1. K. Hoffman and R. Kunze, Linear Algebra, PHI, 1971.

2. S. Roman, Advanced Linear Algebra, Springer, 2007.

MATHP-205
COMPUTER PROGRAMMING C++

Time : 6 Hrs

Full Marks:100

Experiment-60, Viva-Voce-20, Record-20

Implement the following by using C++

- I. Implementation of Simple C++ programs
- II. Implementation of Classes, friend function, Static data members, Constructors, Destructors, Inheritances etc

Books Recommended:

- I. E. Balagurusamy: Object-Oriented Programming with C++, 2nd edition, Tata McGraw- Hill Publishing Company Ltd

Books for Reference:

- iii. M.A Welss: Data Structure and Algorithm Analysis in C++, Reason Education, 2000
- iv. S.BLippoman and J.Lamyoie: C++ primer- klesley, 1998

OR

PYTHON

MATH (VAC)-206
MATRIX ALGEBRA

Time: 3Hours

Full Marks: 100(80+20)

Unit-I

Introduction to Linear Equations, Using Matrices To Solve Systems of Linear Equations, Elementary Row Operations and Gaussian Elimination, Existence and Uniqueness of Solutions, Applications of Linear Systems.

Unit-II

Matrix Addition and Scalar Multiplication, Matrix Multiplication, Visualizing Matrix Arithmetic in 2D, Vector Solutions to Linear Systems, Solving Matrix Equations $AX = B$, The Matrix Inverse, Properties of the Matrix Inverse.

Unit-III

The Matrix Transpose, The Matrix Trace, The Determinant, Properties of the Determinant, Cramer's Rule.

Unit-IV

Eigenvalues and Eigenvectors, Properties of Eigenvalues and Eigenvectors, Transformations of the Cartesian Plane, Properties of Linear Transformations, Visualizing Vectors: Vectors in Three Dimensions.

Book Recommended

Fundamental of Matrix Algebra by Gregory Hartman, Virginia, Military institute

SEMESTER-III
MATHC -301GRAPH THEORY

Time: 3 Hours

Full Marks: 100(80+20)

Unit-I

Graphs, Basic Concepts, Different Types of Graphs, Incidence and Degree of a Graph, Isolated and Pedant Vertex, Isomorphism, Sub-Graphs.

Unit-II

Walk, Path and Circuit of a Graph, Cut-Sets, Cut-Vertices, Planar Graphs, Euler Formula, Hamiltonian Paths and Circuits, Chromatic Numbers, Incidence Matrix, Adjacency Matrix, Directed Graphs.

Unit-III

Types of Digraphs, Adjacency Matrix of Digraphs, Trees and Properties, Rooted Trees, BinaryTrees, Spanning Trees Prime"s&Kruskal"s Algorithm, Minimal Spanning Tree.

Unit-IV

Directed Tree, Enumeration of Graphs, Signal Flow Graphs, Network Flows: Graphs as Models Of Flow Of Commodities, Flows, Maximal Flows And Minimal Cuts, Max-Flow and Min-Cut Theorem

Books Recommended

1. C. Vasudev: Graph Theory with Applications, New Age International Publishers, New Delhi
2. Narsingh Deo: Graph Theory with Applications to Engineering and Computer Science, Prentice-Hall of India

Books for Reference

1. J.P. Tremblay, R. Manohar. Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw-Hill Edn.
2. Y.N. Singh: Mathematical Foundation of Computer Science, New age International Publishers.

MATHC -302FUNCTIONAL ANALYSIS

Time: 3 Hours

Full Marks: 100(80+20)

Unit-I

Fundamental of Normed Spaces: Normed Spaces, Examples, Continuity of Linear Maps, Equivalent Norms, Hahn-Banach Theorem for Real Line Spaces, Banach Spaces and Examples, Quotient Spaces.

Unit-II

Bounded Linear Maps on Banach Spaces: Uniform Bounded Principle, Open Mapping Theorems, Closed Graph Theorems, Spectrum of a Bounded Operator.

Unit-III

Spaces of Bounded Linear Functional: Dual and Transposes, Dual of $L([A,B])$ and $C([A,B])$, Weak and Weak Convergence, Reflexivity.

Unit-IV

Geometry of Hilbert Spaces: Inner Product Spaces, Hilbert Spaces and Examples, Orthogonal Sets, Bessel's Inequality, Complete Orthogonal Sets and Preservation of Identity. Geometry of Hilbert Spaces: Approximation and Optimization, Projection and Riesz Representation.

Books Recommended

1. B.V. Limaye- Functional Analysis, New Age International Ltd (2^a Edn), 1995. Ch:II (Art:5,6,7: 7.1-7.11,8), Ch-III (Art: 9: 9.1-9.3, 10,12: 12.1-12.4), Ch-IV (Art:13, 14: 14.1-14.5,15: 15.1-15.4,16: 16.1-16.2), Ch-VI (Art:21,22,23,24: 24.1-24.6)

MATHC -303 ABSTRACT ALGEBRA

Full Marks: 100(80+20)

Time: 3 Hours

Unit-I

Group Theory: Homomorphisms, Isomorphisms, Automorphisms, Cauchy's Theorem, Cayley's Theorem, Sylow's Theorem.

Unit-II

Group Theory: Direct Products, Finite Abelian Groups. Ring Theory: Definition and Examples of Rings, Some Special Classes of Rings, Homomorphisms, Ideals and Quotient Rings.

Unit-III

More Ideals and Quotient Rings, The Field of Quotients of an Integral Domain, Euclidean Rings, A Particular Euclidean Ring, Polynomial Rings, Polynomial over the Rational Field.

Unit-IV

Field : Extension Fields, Roots of Polynomials, More About Roots, The Elements of Galois Theory, Solvability of radical, Galois groups over the rationals.

Books Recommended

- 1.I.N. Herstein: Topics in Algebra, Vikas Publishing House Pvt. Ltd.
Chapters: 2(2.7-2.9, 2.12-2.14), 3(3.1-3.10), 5(5.1, 5.3-5.8)
- 2.Joseph A. Gallian: Contemporary Abstract Algebra, Cengage
- 3.Musili, Introduction to Rings and Modules, Narosa.

Books for Reference

1. Seymour Lipschutz: Theory and Problems of Linear Algebra, Schaum's Outline Series: McGraw-Hill Book Company.
2. P.B. Bhattacharya, S.K. Jail and S.R. Nagpaul

MATHE (OE) -304
FUZZY LOGIC AND SET THEORY-I

Time: 3 Hours

Full Marks: 100(80+20)

Unit-I

Multi-Level Interval Numbers: Two Level Interval Numbers, Arithmetic Operation with Two Level Intervals, More General Two Level Intervals, Interval Numbers with N-Levels, General N-Level Intervals, Infinite Level Interval Numbers, **Fuzzy Numbers:** Fuzzy Numbers with a Maximum, Triangular, Bell-Shaped, Flat and Trapezoidal Fuzzy Numbers, Piecewise Quadratic Fuzzy Numbers with a Flat, Fuzzy Number Describing „Large“, Fuzzy Numbers in the Set of Integers, Fuzzy Numbers of Dimension Two.

Unit-II

Arithmetic with Fuzzy Numbers: Introduction to Operations with Fuzzy Numbers, Addition, Subtraction, Multiplication, and Division of Fuzzy Numbers, Distance between Triangular Fuzzy Numbers, Fuzzy Operations in the Set of Integers. **Fuzzy Sets:** Definition of Fuzzy Sets, Fuzzy Sets and Fuzzy Numbers, Basic Operations on Fuzzy Sets, Properties of Fuzzy Sets.

Unit-III

Algebraic Product and Sum of Fuzzy Sets, Power and Related Operations on Fuzzy Sets, The Extension Principle, Fuzzy Relations: Definition of Fuzzy Relation, Basic Operations on Fuzzy Relations, Direct Product.

Unit-IV

Projections of a Fuzzy Relations, Max-Min and Min-Max Compositions, Basic Properties of Fuzzy Relations, Fuzzy Relations and Approximate Reasoning. Classical and Many-Valued Logic: Basic Concept of Classical Logic, Propositional and Predicate Calculus, Three Valued Logic, Many-Valued Logic.

Books Recommended

1. George Bojadziev, “Fuzzy Sets, Fuzzy Logic, Applications” World Scientific

OR

MATH(OE)-304
DESIGN AND ANALYSIS OF ALGORITHMS-I

Time- 3Hrs

Full Mark: 100(80+20)

Unit-I

The Role of Algorithms in Computing: Algorithms, Algorithms as a Technology. Running Time of an Algorithm: Definition, Best Case, Average Case, Worst Case Running Time of an Algorithm. Growth of Functions: Asymptotic Notations, Standard Notation and Common Function. Recurrences: The Substitution Method, The Recursion- Tree Method, The Master Method.

Unit-II

Insertion Sort Algorithm, The Divide and Conquer Approach: Merge Sort Algorithm and Its Analysis. Heap Sort: Heaps, Maintaining the Heap Property, Building a Heap, The Heap Sort Algorithms and Its Analysis.

Unit-III

Quick Sort: Description of Quick Sort, Performance of Quick Sort, Analysis of Quick Sort, Sorting in Linear Time: Counting Sort Algorithm. Dynamic Programming: Matrix Chain Multiplication Algorithm.

Unit-IV

Longest Common Subsequence and Its Analysis. Greedy Algorithms: An Activity-Selection Problem, Huffman Codes, Dynamic Programming Versus Greedy Strategy.

Books recommended

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein: Introduction Of Algorithms (Second Edition, Prentice Hall of India, New Delhi) Chapters-1,2 (2.1,2.3), 3,4 (4.1, 4.2,4.3), 6(6.1,6.2,6.3,6.4), 7 (7.1, 7.2, 7.4), 8 (8.2), 15(15.2, 15.4), 16 (16.1, 16.3)

Book for Reference:

1. S.K Basu: Design Methods & Analysis of Algorithms (Prentice Hall of India, NewDelhi)

MATHC - 305
SEMINAR PRESENTATION

Full Marks: 100 (Documentation/Record: 60 + Presentation: 20 + Viva-Voce: 20)

Time: 6 Hours

Course Outcome: Students will gain knowledge on current research of different field in pure and applied mathematics. They can acquire knowledge by the presentation of specific topics and techniques of different research work. Students will get an opportunity to participate in methods of scientific analysis and research procedures. This paper will help them to express their ideas and keep the discussion at a high level of interest. Students will pay attention thoughtfully to contribute their ideas. They will exchange the facts with efforts and the problem solving skills. They can be able to develop vocabulary, articulation, problem solving and critical thinking skills by their presentation. This paper also helps them in self learning and promotes independent thinking.

Contents

Seminar Presentation on Current Research of Pure and Applied Mathematics/Computer Science/Mathematical Physics etc.

MATH (VAC)-306
MATHEMATICAL MODELLING

TIME- 3 Hrs

FULL MARK (80+20=100)

Unit-I

Effects of size, cost of packaging, speed of racing shells, size effects in animals, dimensional analysis, theoretical background, the period of a perfect pendulum, scale models of structures.

Unit -II

Using graphs in modelling, The nuclear missile arms race, biogeography: diversity of species on islands, theory of the firm, cobweb models in economics, small group dynamics.

Unit -III

Optimization By Differentiation, Maintaining Inventories, Geometry of Blood vessels, Fighting Forest Fires, A Bartering Model, Changing Environment and Optimal Phenotype.

Unit-IV

Analytic Models, Sex Preference and Sex Ratio, Making Simple Choices, Monte Carlo Simulation, A Doctor's Waiting Room, Sediment Volume, Stream Networks.

Book Recommended

- An Introduction To Mathematical Modelling by **Edward A. Bender, A wiley- Interscience Publication**
JOHN WILEY & SONS

SEMESTER-IV

MATHC -401 PROBABILITY AND STATISTICS

Time: 3 Hours

Full Marks: 100 (80+20)

Unit-I

Random Variables and Probability Distribution: Concept of a Random Variable, Discrete Probability Distribution, Continuous Probability Distributions, Joint Probability Distribution.

Unit-II

Mathematical Expectation: Mean of Random Variable, Variance and Covariance of Random Variables, Means and Variance of Linear Combinations of Random Variables, Chebyshev's Theorem.

Unit-III

Discrete and Continuous Probability Distribution: Introduction and Motivation, Discrete Uniform Distribution, Binomial, Negative Binomial and Poisson Distribution. Continuous Uniform Distribution, Normal Distribution, Gamma and Exponential Distributions.

Unit-IV

Measures of Central Tendency, Measures of Dispersions, Measure of Skewness and Kurtosis. Multivariate Analysis: Correlation, Correlation Coefficient, Rank Correlation, Regression Analysis, Multiple Regression. Sampling Theory: Population and Sample, Sampling with and without Replacement, Random Samples.

Books Recommended

1. Ronald E. Walpole, Sharon L. Myers, Keying Ye, "Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson Education.
[3.1 To 3.4, 4.1 To 4.4, 6.1 To 6.6]
2. S.C Gupta, V.K. Kapoor, "Fundamental of Mathematical Statistics", Sultan Chand and Sons.
3. Murray R Spiegel, Jhon J Schiller, R Alu Srinivasan, "Probability and Statistics" 3rd Edition Schaum's Out Lines. [5.1 To 5.12]
4. Mukhopadhyaya, P., Mathematical statistics, New central Book Agency, Calcutta.

Books for Reference

3. Parimal Mukhopadhyay, "Mathematical Statistic" Books and Allied (P) Ltd.
4. Robert V. Hogg and Allen T. Craig, "Introduction to Mathematical Statistics" Pearson Education Asia

MATHC -402NUMBER THEORY

Full Marks: 100(80+20)

Time: 3 Hours

Unit-I

Number Theory and Fundamentals of Arithmetic: Divisibility, Greatest Common Divisor, Prime Numbers, The Fundamental Theorem of Arithmetic, The Series of Reciprocals of the Primes, The Euclidean Algorithm, The Greatest Common Divisor of More Than Two Numbers. The Mobius Function $\mu(n)$, The Euler Totient Function $\varphi(n)$, A Relation Connecting φ And μ , A Product Formula For $\varphi(n)$.

Unit-II

Congruences: Definition and Basic Properties of Congruences, Residue Classes and Complete Residue Systems, Linear Congruences, Reduced Residue Systems and The EulerFermat Theorem, Polynomial Congruences Modulo P , Lagrange's Theorem, Applications of Lagrange's Theorem, Simultaneous Linear Congruences, The Chinese Remainder Theorem, Applications of the Chinese Remainder Theorem, Polynomial Congruences with Prime Power Moduli.

Unit-III

Periodic Arithmetical Functions and Gauss Sums: Functions Periodic Modulo k , Existence of Finite Fourier Series for Periodic Arithmetical Functions, Ramanujan's Sum and Generalizations, Multiplicative Properties of the Sums $S_k(n)$, Gauss Sums Associated with Dirichlet Characters.

Unit-IV

Quadratic Residues and Quadratic Reciprocity Law: Quadratic Residues, Legendre's Symbol and Its Properties, Evaluation of $(-1|P)$ and $(2|P)$, Gauss' Lemma, Quadratic Reciprocity Law, Applications of the Reciprocity Law.

Books Recommended

1. Tom M. Apostol: Introduction to Analytic Number Theory, Springer International, Norosa Publishing House.
Chapter: 1, 2 (2.1-2.5), 5 (5.1-5.9), 8 (8.1-8.5), 9 (9.1-9.6)
2. Neal Koblitz: A Course of Number Theory and Cryptography, Second Edition, Springer Verlag New York-1987
3. Elementary Number Theory by David Burton

Books for Reference

1. RamanujachanjKumanuri and Christina Romero: Number Theory with Computer Applications, Printice Hall, New Jery-1998
2. H. Delfs& H. Knebl- Introduction to Cryptography Principle and Application, Springer Verlag-2002
3. D. R Stinson: Cryptography- Theory of Practice (3rdEdn) Chapman Hall/ CRC-2006

MATHC -403 REAL ANALYSIS

Time: 3 Hours

Full Marks: 100(80+20)

Unit-I

Real Number System and Set Theory: Completeness Property, Archimedean Property, Denseness of Rationals and Irrationals, Countable and Uncountable. Metric Spaces: Open Sets, Closed Sets.

Unit-II

Continuous Functions, Completeness, Cantor Intersection Theorem, BaireCategory Theorem, Compactness, Totally Boundedness, Finite Intersection Property. Riemann-Stieltjes Integral: Definition and Existence of the Integral.

Unit-III

Riemann-Stieltjes Integral: Properties of the Integral, Differentiation and Integration. Sequence and Series of Functions: Uniform Convergence, Uniform Convergence and Continuity.

Unit-IV

Sequence and Series of Functions: Uniform Convergence and Integration. Uniform Convergence and Differentiation. Equicontinuity, Ascoli's Theorem, Weierstrass Approximation Theorem.

Books Recommended

1. W. Rudin: Principles of Mathematical Analysis, McGraw-Hill
2. T. Apostol: Mathematical Analysis, Narosa Publishers
3. H. L. Royden: Real Analysis (Third Edition, Prentice-Hall of India)

Books for Reference

1. Hewitt E. and Stomberg K. Real and Abstract Analysis: A Modern Treatment of the Theory of Functions of a Real Variable, Springer
2. K. Ross K. Elementary Analysis: The Theory of Calculus, Springer

MATHE(OE)-404
FUZZY LOGIC AND SET THEORY-II

Full Marks: 100 (80+20)

Time: 3 Hours

Unit-I

Fuzzy Logic: What is Fuzzy Logic, Linguistic Variables, Linguistic Modifiers, Truth, Proposition of Fuzzy Logic, Composition Rules for Propositions.

Unit-II

Quantification Rules, Qualification Rules, Semantic Equivalence, Semantic Entailment, Approximate Reasoning.

Unit-III

Decision Making and Applications: Decision Making, Fuzzy Delphi Method for Forecasting, Fuzzy Zero Based Budgeting

Unit-IV

Fuzzy Logic Control and Applications: Introduction, Modeling the Control Parameters, If and Then Rules, Rule Evaluation, Conflict Resolution, Diffusification, Washing Machine, Fuzzy Logic Control Predictor-Prey System.

Book Recommended

1. George Bojadziev, Maria Bojadziev, "Fuzzy Sets, Fuzzy Logic, Applications"
World Scientific

OR

DESIGN AND ANALYSIS OF ALGORITHMS-II

FULL MARKS: 100(80+20)

TIME: 3 Hours

Unit-I

Data Structures for Disjoint Sets: DisjointSet Operations, Elementary Graph Algorithms: Representation of Graphs, Breadth-First-Search, Depth-First-Search, Minimum Spanning Trees: Growing a Minimum Spanning Tree, Krushkal's Algorithm, Prim's Algorithm.

Unit-II

Single Source Shortest Paths: The Bellman-Ford Algorithm, Dijkstra's Algorithm, All Pair Shortest Paths: The Floyd-Warshall Algorithm, Maximum Flow: Flow Networks, The Ford-Fulkerson Method, String Matching: The Naive String-Matching Algorithm, The Rabin-Karp Algorithm.

Unit-III

Computational Geometry: Line-Segment Properties, Determining whether any Pair of Segments Intersects. NP-Completeness: NP-Completeness and The Classes P and NP, Reductions. Polynomial Time: Definition, A Formal Language Framework.

Unit-IV

Polynomial Time Verification: Hamiltonian-Cycle Problem, Verification Algorithm, The Complexity Class NP, NP-Completeness Problems (Only Definition and List of NP- Complete Problems without Proof) and Reducibility: Reducibility, Circuit Satisfiability, Approximation Algorithm: Performance Ratios for Approximation Algorithms, Travelling Sales Man Problem.

Books Recommended

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein: Introduction to Algorithms (Second Edition, P.H.I, New Delhi)
Chapters-21(21.1), 22(22.1, 22.2, 22.3), 23 (23.1, 23.2), 24(24.1, 24.3), 25(25.2). 26(26.1, 26.2), 32(32.1, 32.2), 33(33.1, 33.2), 34(34.1, 34.2, 34.3), 35(35.2)

MATHC -405 DISSERTATION, PRESENTATION AND VIVA-VOCE

Full Marks: 100

Course Outcome: The dissertation is the task that the students have to do at Semester -IV level. It is a task that helps the students in presenting the research they have done while pursuing their degree. It could give an idea of how much knowledge they boast of the things learned in the academics and how dedicated they are, towards doing their own research on a topic. When the students start the research, they only have some random idea about their topic for research paper. Additionally, when they will start writing the paper then, they will be able to feel like what new they can do because many others have already done the same research. However, when the students will start working on their topic, they will find a little gap between the topics and there they will find a way to fill the gap. They will find a way to present their research paper to the world and that's the more important points for their studies.

Contents

Any one of the following subjects shall be chosen from part A or part B

Part-A: Soft Computing / Artificial Intelligence

1. Fuzzy Set
2. Rough Set
3. Data Mining
4. Soft Set
5. Near Set
6. Knowledge Management
7. Biotechnology
8. Expert System
9. Image Processing
10. Neural Network
11. Cluster Techniques
12. Pattern Recognition
13. Cloud Computing
14. Mobile Computing
15. Granular Computing
16. Signal Processing
17. Analysis and Design of Algorithms
18. Any other topic suggested by teaching faculty

Part-B: Graph Theory

1. Trees and Fundamental Circuits, Dual Graphs
2. Planar Graphs, Vector Spaces of a Graph
3. Matrix Representation of Graphs, The Four Color Problem, Coverings
4. Directed Graphs, Graphs in Switching and Coding Theory
5. Network Analysis by Graph, Graph Theory in Operations Research