TUMKUR UNIVERSITY

Department of Studies & Research in Mathematics

M.Sc. MATHEMATICS - SYLLABI

(Academic Year 2024-25)

Choice Based Credit System (CBCS)
Semester Scheme

Choice Based Credit Systems (CBCS) –Semester Course
M. Sc., MATHEMATICS

Name of the Course: M. Sc., Mathematics

Medium of Instruction: The medium of instruction shall be English.

Duration: The M.Sc. Degree Course is of two years duration, spread over four semesters each of four months duration.

Attendance: Every student must have at least 75% attendance in each of the courses (Theory & Practical) in each semester.

Abbreviated Course Subject Codes:

CPT: Core Paper Theory	**CPP:** Core Paper Practical
OEPT: Open Elective Paper	**SPT:** Special Paper Theory
OEPP: Open Elective Practical	**SPP:** Special Paper Practical

Special Paper Theory (SPT) Selection:

One Special Paper Theory (SPT) has to be chosen from the given Special papers in II, III and IV – Semester M.Sc., Mathematics as per the availability of faculties in respective specialization.

Computer Programming Practicals:

In I Semester CPP- 1.4.2 , II Semester CPP -2.4.2 and OEPP-2.6.2, III semester SPP-3.5(C) and OEPP-3.6.2, each student will have 2 hours of Practical per week. Practical classes will be conducted in batches of approximately 15 students in each batch.

Examination & Dissertation: Shall be follows as per Tumkur University CBCS regulation.

Internal Assessment Marks allotment **Total = 30 Marks**

1st Test for 20 Marks + 2nd Test for 20 Marks	Average of two tests = **20 Marks**
Assignment	= **07 Marks**
Attendance	= **03 Marks**

Internal Assessment Marks allotment of Practical/Practical based theory

One theory based test (in CPT-1.4.1, CPT-2.4.1, SPT-3.5(C), OEPT-2.6.1 and OEPT-3.6.1 each) and **One** laboratory test (in CPP-1.4.2, CPP-2.4.2, SPP-3.5(C), OEPP-2.6.2 and OEPP-3.6.2 each) should be conducted for 15 Marks.

TUMKUR UNIVERSITY

Department of Studies & Research in Mathematics

M. Sc., Mathematics - Choice Based Credit System (CBCS)- Course Contents

I Semester

Sl. No.	Paper	Title of the paper	Instruction Hrs per Week	No. of Credits	Duration of the Exam.	Marks		
						IA	Semester End Examn.	Total Marks
1	CPT-1.1	Algebra	4	4	3 Hrs	30	70	100
2	CPT-1.2	Real Analysis I	4	4	3 Hrs	30	70	100
3	CPT-1.3	Ordinary Differential Equations	4	4	3 Hrs	30	70	100
4	CPT-1.4.1	Numerical Analysis	2	2	2 Hrs	15	35	50
	CPP-1.4.2	Python Lab I	4	2	3 Hrs	15	35	50
5	CPT-1.5	Discrete Mathematics	4	4	3 Hrs	30	70	100
6	CPT-1.6	Continuum and Classical Mechanics	4	4	3 Hrs	30	70	100
		Total	**26**	**24**				**600**

II Semester

Sl. No.	Paper	Title of the paper	Instruction Hrs per Week	No. of Credits	Duration of the Exam.	Marks		
						IA	Semester end Examn.	Total Marks
1	CPT-2.1	Real Analysis II	4	4	3 Hrs	30	70	100
2	CPT-2.2	Topology I	4	4	3 Hrs	30	70	100
3	CPT-2.3	Partial Differential Equations	4	4	3 Hrs	30	70	100
4	CPT-2. 4. 1	Advanced Numerical Analysis	2	2	2 Hrs	15	35	50
	CPP-2. 4 .2	Python Lab II	4	2	3 Hrs	15	35	50
5	SPT-2.5(A)	Combinatorics and Number Theory	4	4	3 Hrs	30	70	100
	SPT-2.5(B)	Operations Research						
6	OEPT-2.6.1*	Foundations of Mathematics	4	4	3Hrs	30	70	100
	OEPP-2.6.2*	Scilab-Programming Lab I	4	2	2 Hrs	15	35	50
		Total	**30**	**26**				**650**

*****To be offered to other departments .

III Semester

Sl. No.	Paper	Title of the paper	Instruction Hrs per Week	No. of Credits	Duration of the Exam.	Marks		
						IA	Semester End Examn.	Total Marks
1	CPT-3.1	Topology II	4	4	3 Hrs	30	70	100
2	CPT-3.2	Linear Algebra	4	4	3 Hrs	30	70	100
3	CPT-3.3	Complex Analysis	4	4	3 Hrs	30	70	100
4	CPT-3.4	Fluid Mechanics	4	4	3 Hrs	30	70	100
5	SPT-3.5(A)	Non linear dynamics	4	4	3 Hrs	30	70	100
	SPT-3.5(B)	Design and Analysis of Algorithms	4	4	3 Hrs	30	70	100
	SPT-3.5(C)	Machine Learning and Artificial intelligence	2	2	2 Hrs	15	35	50
	SPP-3.5(C)	Machine Learning and Artificial intelligence Lab	4	2	3 Hrs	15	35	50
6	OEPT-3.6.1*	Elements of Applied Mathematics	4	4	3hrs	30	70	100
	OEPP-3.6.2*	Scilab-Programming Lab II	4	2	3 Hrs	15	35	50
		Total	**30**	**26**				**650**

*****To be offered to other departments.

IV Semester

Sl. No.	Paper	Title of the paper	Instruction Hrs per Week	No. of Credits	Duration of the Exam.	Marks		
						IA	Semester End Examn.	Total Marks
1	CPT-4.1	Measure and Integration	4	4	3 Hrs	30	70	100
2	CPT-4.2	Functional analysis	4	4	3 Hrs	30	70	100
3	CPT-4.3	Probability and Statistics	4	4	3 Hrs	30	70	100
4	CPT-4.4	Mathematical Methods	4	4	3Hrs	30	70	100
5	SPT-4.5(A)	Magnetohydrodynamics	4	4	3 Hrs	30	70	100
	SPT-4.5(B)	Differential Geometry						
	SPT-4.5(C)	Galois Theory						
	SPT-4.5(D)	Advanced Graph Theory						
6	CPD	Dissertation	4	4	-	30 (Viva-voce)	70 (Report)	100
		Total	**24**	**24**				**600**

IA: Internal Assessment **CPT:** Core Paper Theory **CPP:** Core Paper Practical
SPT: Special Paper Theory **SPT:** Special Paper Practical **CPD:** Core paper Dissertation
OEPT: Open Elective Paper Theory **OEPP:** Open Elective Paper Practicles

FIRST SEMESTER M. Sc. MATHEMATICS (CBCS)

CPT-1.1: ALGEBRA

UNIT-1. **16Hrs.**

Elements of Number theory, Congruences, residue classes, theorems of Fermat, Euler and Wilson, linear congruences, Chinese Remainder theorem, elementary arithmetical functions.

Isomorphism theorems, Automorphisms, Groups of automorphisms and inner automorphisms, Permutation groups and dihedral groups - Cayley's theorem, Direct Products of groups.

UNIT-2. **16Hrs.**

Conjugate elements - Class equations, Cauchy's theorem and Sylow's theorems-applications. Tests on simplicity of a finite group, Finite abelian groups, fundamental theorem.

UNIT-3. **16Hrs.**

Ideals and Quotient rings, Fundamental theorem of homomorphism of rings, Maximal ideals and Prime ideals, imbedding of rings Field of Quotients of an Integral Domain, Euclidean domains and Principle Ideal domains, unique factorization theorem.

UNIT-4. **16Hrs.**

Polynomial rings, primitive polynomials, Gauss lemma, irreducibility criterion: Mod *p* irreducibility test, Eisenstein's Criterion, Polynomial rings over commutative rings, unique factorization domains.

TEXT BOOKS

1. D. M. Burton : Elementary Number Theory, Tata McGraw-Hill, New Delhi, 6th Ed.,
2. I.N.Herstein : Topics in Algebra, 2nd Edition, Vikas Publishing House, 1976.
3. J.B.Fraleigh : A first course in Algebra, 3rd Edition, Narosa, 1996.
4. I. Niven, H. S. Zuckerman and H. L. Montgomery : An Introduction to the Theory of Numbers, New York, John Wiley and Sons, Inc., 2004, 5th Ed.,

REFERENCE BOOKS

1. M. Artin : Algebra, Prentice Hall of India, 1991.
2. D. S. Dummit and R. M. Foote – Abstract Algebra, John Wiley and Sons, 1999.
3. J. A. Gallian – Contemporary Abstract Algebra, Narosa Publishing House, 4th Ed.,
4. N. Jacobson : Basic Algebra-I, HPC, 1984.

CPT-1.2: REAL ANALYSIS I

UNIT-1. **16Hrs.**

Equivalent sets, countable and uncountable sets, cardinal numbers, Cantor's theorem, continnum hypothesis, Zorn's lemma.

Basic topology of real line, bounded sets, Archimedean property, open sets, closed sets, limit points, compact sets, Bolzano Weierstrass property, Heine Borel theorem, connected sets.

UNIT-2. **16Hrs.**

Convergent sequences, subsequences, Cauchy sequences, some special sequences, limit superior and inferior, series, series of non-negative series, summation by parts, absolute convergence, addition and multiplication of series, rearrangement.

UNIT-3. **16Hrs.**

Continuity, limits of a function, continuous functions, discontinuity, properties of continuous functions, intermediate value property, fixed point property, continuity and compactness, continuity and connectedness, uniform continuity.

UNIT-4. **16Hrs.**

The derivative of a real function, Darboux property, mean value theorems, continuity of derivatives, derivatives of higher order, Taylor's theorem.

TEXT BOOKS

1. W. Rudin: Principles of Mathematical Analysis, McGraw-Hill, 1983.
2. S. C. Malik and Savita Arora: Mathematcal Analysis, 2nd ed., New Age Intn. (P) Ltd., 1992

REFERENCE BOOKS

1. T. M Apostol: Mathematical Analysis, 2nd ed. Narosa, 1988
2. S. Goldberg: Methods of Real Analysis, OUP, 1970

CPT-1.3: ORDINARY DIFFERENTIAL EQUATIONS

UNIT-1. **16Hrs.**

Homogeneous equations of order n and general solutions; Initial value problems; existence and uniqueness of solutions, linear dependence and independence of solutions, Solutions of non homogeneous equations by Method of Variation of parameters, Method of Undetermined Coefficients. Linear equations with variable coefficients, reduction of order of the equation.

UNIT-2: **16Hrs.**

Introduction, Oscillatory and non- Oscillatory differential equations and some theorems on it. Boundary value problems, Sturm Liouville theory, Green's function.

UNIT-3: **16Hrs.**

Solution in Terms of Power Series: -Solution near an ordinary point and a regular singular point–Frobenius method–Legendre, Bessel's and Hyper geometric equations and their polynomial solutions, Rodregue's relation, generating functions, orthogonal properties, and recurrence relations.

UNIT-4: **16Hrs.**

Solution by successive approximations, Lipschitz condition, Convergence of successive approximations, Existence and Uniqueness theorem (Picard's theorem).
First order systems, linear system of homogeneous and non-homogeneous equations (matrix method), Introduction to Non-linear equations.

TEXT BOOKS

1. E. A. Coddington : An Introduction to Ordinary Differential Equations
2. Simmons, G.F. : Differential Equations with Applications and Historical Notes

REFERENCE BOOKS

1. M.S.P.Eastham : Theory of ordinary differential equations
2. S.L.Ross : Differential equations (3rd edition)
3. Deo S.G, and Raghavendra V : Ordinary Differential Equations and Stability Theory
4. E.A.Coddington and N.Levinson : Theory of ordinary differential equations :
5. A.C.King, J.Billingham and S.R.Otto: Differential equations

CPT- 1.4.1: NUMERICAL ANALYSIS

UNIT-1. **08Hrs.**

Nonlinear Equations in One Variable: Fixed point iterative method - convergence and acceleration by Aitken's 2 -process. Newton Raphson methods, Ramanujan method, Sturm sequence for identifying the number of real roots of the polynomial functions.

UNIT- 2. **08Hrs.**

Linear System of Equations: Direct methods: Gauss Eliminations with Pivotal Strategy, LU - decomposition methods (Crout's, Cholesky methods). Iteration methods: matrix norm, consistency and ill conditioned system of equations, Jacobi, Gauss Seidel, Iterative Methods with convergence criterion. Eigenvalue and Eigen Vectors: Jocobi's method, Given's method, House holders method.

UNIT -3. **08Hrs.**

Interpolation: Lagrange, Hermite, Cubic-spline interpolation, error of interpolation, Orthogonal polynomials, Least Square approximation. Grams-Schmidt Orthogoralization process, Legendre, Chebyshev polynomial approximation.

UNIT-4. **08Hrs.**

Introduction to Python, Execute Python, Variables, Identifiers, Control Statement, Python Strings, Basic Operators, Slice Notation, String functions and Methods, Python Data Structures, Python Functions, Use of Sympy package, Symbols, Recursive Solutions, Python OOPs, Python Modules.

TEXT BOOK

1. M. K. Jain, S. R. K.Iyengar and R.K.Jain: Numerical Methods for Scientific & Engineering Computation, 3rd Ed.Wiley Eastern Ltd. 1993.
2. Burden R and Faires J. D.: Numerical Analysis, P.W.S. 4th Ed.Kent Pub. Co., Boston, 1989.
3. Atkinson K.E.: An Introduction to Numerical Analysis, 3rd Ed., John Weiley & Sons, 1989.

REFERENCE BOOKS:

1. S. C. Chapra and P.C. Raymond: Numerical Methods for Engineers, Tata McGraw Hill, New Delhi, 2000.
2. Conte S.D. and De Boor: Introduction to Numerical Analysis. McGraw Hill.
3. Hilderband F.B.: Introduction to Numerical Analysis, 5th Ed., Tata McGraw Hill, New
Delhi, (1986).
4. Gerald C. F. and Wheatly P. O.: Applied Numerical Methods, 6th Ed., Low Price Ed., Pearson Ed. Asia, 2002.

CPP- 1. 4. 2 : PYTHON LAB I

LIST OF PROGRAMS:

1. Data Visualization : Standard plots (2D, 3D), Scatter plots, Slope fields, Vector fields, Contour plots, stream lines, Manipulating and data visualizing data with Pandas.
2. Program to plot a neat labeled graph of functions f(x)=x^2, g(x)=x^3 – 1, h(x)=e^x and some trigonometric function.
3. Write a program to find the area of rectangle. square, circle and triangle by accepting suitable input parameters from user.
4. Program to obtain the graph of plane curves cycloid, asteroid, elliptical helix circular helix, paraboloid, hyperbolic paraboloid etc in separate figure on a single run.
5. Write a program to display the first 'n' terms of Fibonacci series.
6. Write a program to find factorial of the given number.
7. Write a program to calculate the sum and product of two compatible matrices.
8. Write a program to find the transpose and norm of a matrix.
9. Write a program to find real root of a polynomial using fixed point iterative method.
10. Write a program to find real root of a polynomial using Newton Raphson Method.
11. Write a program to find the value of function using Lagrange interpolation method.
12. Write a program to find the value of function using Hermite interpolation method.
13. Write a program to solve system of equations using Gauss Elimination Method.
14. Write a program to find solution of system of equations using Jacobi Iterative Method.
15. Write a program to find solution of system of equations using Gauss Seidal Method.

TEXT BOOKS

1. Martin C. Brown: The Complete Reference Python, McGraw Hill.
2. Magnus Lie Hetland: Beginning-Python, Third Edition, Apress 2017.

REFERENCE BOOKS:

1. Patrick Barry: Head First Python, Third Edition, O'Reilly 2023.
2. Mark Lutz : Learning Python, Fifth Edition, O'Reilly 2017.
3. Alex Martelli: Python in a Nutshell, Fourth Edition, O'Reilly 2023.

CPT-1.5: DISCRETE MATHEMATICS

UNIT-1. **16Hrs.**

Logic: Introduction to logic, Propositional logic syntax, logical equivalence, Rules of Inference: Modus Ponens, Modus Tollens, Hypothetical Syllogism, Disjunctive Syllogism, Validity of Arguments, Methods of proof, Predicate logic, interpretation/value of a term.

UNIT-2. **16Hrs.**

Recurrence relations, Modeling with recurrence relations with examples of Fibonacci numbers. Generating functions, definition with examples. List of generating functions. exponential generating functions. Difference equations. Definition and types of relations. Representing relations using matrices and digraphs. Closures of relations, Paths in digraphs, Transitive closures. Warshall's Algorithm.

UNIT-3. **16Hrs.**

Partial Ordered sets, Hasse diagrams, Isomorphism, Extremal elements in poset, Lattice, Distributive lattice, Complemented lattice, Boolean lattices, Boolean Algebras, Boolean functions, Karnaugh Map, Normal forms, Conjunctive and disjunctive normal forms, Applications to Switching circuits.

UNIT-4. **16Hrs.**

Introduction to graph theory, types of graphs, Subgraphs, Degree, Distance, Standard graphs, Bipartite graph, Regular graph, Complement of a graph, Graph isomorphism, Graph Operations. Eulerian and Hamiltonian graphs, Hamiltonicity: noting the complexity of hamiltonicity. Trees, Characterization of trees, Rooted trees, Binary trees, Spanning trees.

TEXT BOOKS

1. C. L. Liu: Elements of Discrete Mathematics, Tata McGraw-Hill, 2000.
2. F. Harary: Graph Theory, Addition Wesley, 1969.
3. G. Chartrand and P. Zhang. Introduction to Graph Theory, Tata McGraw-Hill, 2006.

REFERENCE BOOKS

1. N. Chandrasekaran and M. Umaparvathi: Discrete Mathematics, PHI, New Delhi, 2010.
2. J. A. Bondy and U. S. R. Moorthy: Graph theory with applications. Elsevier Sc., 1982.
3. Kenneth Rosen: WCB McGraw-Hill, 6th ed., 2004.

CPT- 1.6: CONTINUUM AND CLASSICAL MECHANICS

UNIT-1. **16Hrs.**

Co-ordinate transformations, Cartesian tensors, Basic properties, Transpose of a tensor, Symmetric and Skew tensors, Dual vector of a skew tensor, scalar, vector and tensor functions, Comma notations, Gradient, Divergence and curl in tensor calculus, integral theorems.

UNIT-2. **16Hrs.**

Continuum Hypothesis, Deformation gradient, Stretch and rotation, Strain tensors, Strain-displacement relations, Infinitesimal strain tensor, compatibility conditions, Principal strains. Material and local time derivatives, path lines, stream lines and vortex lines, Transport formulas. Vorticity and Circulation.

UNIT-3. **16Hrs.**

Body forces and surface forces, Stress components and stress tensor, Normal and shear stresses, Principal stresses. Stress deviator, Boundary condition for the stress tensor. Laws of conservation of mass, Principles of Linear and angular momentum, Balance of energy.

UNIT-4. **16Hrs.**

Generalized coordinates, Lagrange's equations, Hamilton Canonical equations, Hamilton's principle and principle of least action, Two dimensional motion of rigid bodies, Euler's dynamical equations for the motion of a rigid body about an axis, theory of small oscillations.

TEXT BOOKS

1. D. S. Chandrasekharaiah and L. Debanath: Continuum Mechanics, Academic Press, USA, 1994.
2. V B Bhatia: Classical Mechanics, Narosa Publishing House.

REFERENCES

1. P. Chadwick : Continuum Mechanics, Allen and Unwin, 1976.
2. L. E. Malvern : Introduction to the Mechanics of a Continuous Media, Prentice Hall, 1969.
3. T. J. Chung: Applied Continuum Mechanics, Cambridge University Press, 1996.
4. H Goldstien: Classical Mechanics, Narosa Publishing House.

SECOND SEMESTER M. Sc. MATHEMATICS (CBCS)

CPT-2.1: REAL ANALYSIS II

UNIT-1. **16Hrs.**

The Riemann - Stieltjes Integral: Definitions and existence of the integral, Linear properties of the integral, the integral as the limit of sums, Integration and Differentiation, Integration of vector valued functions. Function of bounded variation- First and second mean value Theorems, Change of variable rectifiable curves.

UNIT-2. **16Hrs.**

Sequence and series of Functions: Pointwise and Uniform Convergence, Cauchy Criterion for uniform convergence, Weierstrass M-test, Uniform convergence and continuity, Uniform convergence and Riemann - Stieltjes Integration, Bounded variation, Uniform convergence and Differentiation. Uniform convergence and bounded variation - Equicontinuous families of functions, uniform convergence and boundedness.

UNIT-3. **16Hrs.**

The Stone-Weierstrass theorem and Weierstrass approximation of continuous function, illustration of theorem with examples. Properties of power series, exponential and logarithmic functions, trigonometric functions. Topology of Rn , k-cell and its compactness, Continuity, Compactness and uniform continuity.

UNIT-4. **16Hrs.**

Functions of several variables, continuity and differentiation of vector-valued functions, Linear transformation of R^k , properties and invertibility, directional derivative, chain rule, partial derivative, Hessian matrix, the inverse function theorem and implicit function theorem.

TEXT BOOKS

1. W. Rudin : Principles of Mathematical Analysis, McGraw Hill, 1983.
2. T. M. Apostol: Mathematical Analysis, New Delhi, Narosa, 2004.

REFERENCE BOOKS

1. S. Goldberg: Methods of Real Analysis, Oxford & IBH, 1970.
2. J. Dieudonne: Treatise on Analysis, Vol. I, Academic Press, 1960.

CPT-2.2 TOPOLOGY I

UNIT-1. **16Hrs.**

Definition of a metric, open and closed balls, Cauchy and convergent sequences, complete metric spaces, continuity, contraction mapping theorem, Banach fixed point theorem, bounded and totally bounded sets, Cantor's intersection theorem, nowhere dense sets, Baire's category theorem, isometry, embedding of a metric space in a complete metric space

UNIT-2. **16Hrs.**

Topology, definition and examples, open and closed sets, neighborhoods and limit points, closure, interior and boundary of a set, relative topology, bases and sub-bases, continuity and homeomorphism, pasting lemma.

UNIT-3. **16Hrs.**

Connected spaces, definition and examples, connected sets in the in the real line, intermediate value theorem, components and path components, local connectedness and path connectedness.

UNIT-4. **16Hrs.**

Compact spaces, compact sets in the real line, limit point compactness, sequential compactness and their equivalence for metric spaces, locally compact spaces, compactification, Alexandroff's one point compactification.

TEXT BOOKS

1. J. R. Munkres, Topology, Second Edition, Prentice Hall of India, 2007
2. W.J. Pervin : Foundations of General Topology - Academic Press, 1964.

REFERENCE BOOKS

1. G. F. Simmons: Introduction to Topology and Modern Analysis – Tata Mc Graw Hill, 1963.
2. J. Dugundji: Topology - Prentice Hall of India, 1975.
3. J.L. Kelley, General Topology, Van Nostrand, Princeton, 1955.

CPT-2.3: PARTIAL DIFFERENTIAL EQUATIONS

UNIT-1. **16Hrs.**

Solutions of partial differential equation using Charpit's Method, Method of Cauchy Characteristics, Method of Separation of Variables, Second Order Partial Differential Equations: Introduction, Origin of Second Order Equations, Equations with Variable Coefficients, Canonical Forms.

UNIT-2. **16Hrs.**

Elliptic Equations: Introduction, Solutions by Separation of Variables, Solutions by Eigen functions Expansion Method, Solutions by Fourier Transform Method, Similarity Transformation Method, Solutions to Higher Dimensional Equations, Solutions to elliptic equations in cylindrical and spherical coordinate systems.

UNIT-3. **16Hrs.**

Parabolic Equations: Introduction, Solutions by Separation of Variables, Solutions by Eigen function Expansion Method, Solutions by Laplace Transform Method, Solutions by Fourier Transforms Method, Duhamel's Principle, Higher Dimensional Equations, Solutions to parabolic equations in cylindrical and spherical coordinate systems.

UNIT-4. **16Hrs.**

Hyperbolic Equations: Introduction, Method of Characteristics (D'Alembert Solution), Solutions by Separation of Variables, Solutions by Eigenfunctions Expansion Method, Solutions by Laplace Transform Method, Solutions by Fourier Transform Method, Duhamel's Principle, Solutions to Higher Dimensional Equations, Solutions to hyperbolic equations in cylindrical and spherical coordinate systems.

TEXT BOOKS:

1. I.N. Sneddon : Elements of Partial Differential Equations .
2. Tyn Myint-U and Lokenath Debnath: Linear Partial Differential Equations for Scientists and Engineers

REFERENCE BOOKS:

1. Ames, W.F : Nonlinear Partial Differential Equations in Engineering .
2. Debnath, L : Integral Transforms and Their Applications .
3. Stanley J. Farlow : Partial Differential Equations for Scientists and Engineers

CPT-2.4.1: ADVANCED NUMERICAL ANALYSIS

UNIT-1. **08Hrs.**

Numerical Integration, Newton-Cotes integration methods; Trapezoidal rule, Simpson's 1\3rd rule, Simpson's 3\8th rule. Gaussian integration methods and their error analysis, Gauss-Legendre, Gauss-Hermite, Gauss-Legurre and Gauss-Chebyshev integration methods and their error analysis. Romberg integration.

UNIT-2 **08Hrs.**

Numerical Solution of Ordinary Differential Equations: Single Step methods: Runge-Kutta methods of second and fourth order for simultaneous and higher order differential equations. Multi step methods: Adam Bashforth's, Adam Moulton's and Milne's predictor-corrector methods,(Convergence and Truncation error for the above methods). Boundary Value problems: Second order finite difference method, linear shooting method.

UNIT-3 **08Hrs.**

Numerical solution of Partial differential equations: Finite difference approximations to derivatives. Finite Difference methods for Elliptic partial differential equations –Laplace and Poisson's equations.

UNIT- 4. **08Hrs.**

Difference methods for parabolic equations in one-dimensional space- Schmidt, Laasonen, Crank-Nicolson. Explicit and implicit finite difference schemes for hyperbolic equations in one dimensional space. Stability and convergence of the above methods.

TEXT BOOKS

1. M. K. Jain, S. R. K.Iyengar and R.K.Jain : Numerical Methods for Scientific and Engineering Computation, Wiley Eastern Ltd. 3rd Ed. 1993.

2. Burden R. and Faires J. D. : Numerical Analysis, P.W.S. Kent Pub. Co. 4th Ed., Boston, 1989.

3. Atkinson K. E. : An Introduction to Numerical Analysis, 3rd Ed.,John Weiley and Sons, 1989.

REFERENCE BOOKS:

1. S. C. Chapra, and P. C. Raymond: Numerical Methods for Engineers, Tata McGraw Hill, New Delhi, 2000.

2. Conte S. D. and De Boor. Introduction to Numerical Analysis. McGraw Hill.

3. Hilderband F. B. : Introduction to Numerical Analysis, 5th Ed., Tata McGraw Hill, New Delhi, 1986.

4. Gerald C. F. and Wheatly P. O.: Applied Numerical Methods, 6th Ed. Low Priced Ed., Pearson Education Asia, 2002.

CPP-2.4.2: PYTHON LAB II

LIST OF PROGRAMS:

1. Program to evaluate the given integral using Trapezoidal rule.
2. Program to evaluate the given integral using Simpson's 1/3 rule
3. Program to evaluate the integral using Simpson's 3/8 rule.
4. Program to solve initial value problem using Euler Method.
5. Program to solve initial value problem using Euler Modified Method.
6. Program to find solution of initial value problem using RungeKutta II order Method.
7. Program to find solution of initial value problem using RungeKutta IV order Method.
8. Program to find solution of initial value problem using Predictor-Corrector method.
9. Program to find solution of initial value problem using Milne's Method.
10. Program to find value of the function using Lagrange Interpolation Method.
11. Program to find the numerical solution of Laplace equation by Jocobi's method.
12. Program to find the numerical solution of Laplace equation by Gauss-Seidel method.
13. Program to find the numerical solution of Heat equation by Schmidt method.
14. Program to find the numerical solution of Heat equation by Crank-Nicolson method.
15. Program to find the numerical solution of wave equation using Finite difference method.

TEXT BOOKS

3. Martin C. Brown: The Complete Reference Python, McGraw Hill
4. Magnus Lie Hetland: Beginning-Python, Third Edition, Apress 2017.

REFERENCE BOOKS:

4. Patrick Barry: Head First Python, Third Edition, O'Reilly 2023
5. Mark Lutz : Learning Python, Fifth Edition, O'Reilly 2017
6. Alex Martelli: Python in a Nutshell, Fourth Edition, O'Reilly 2023

SPT- 2.5(A): COMBINATORICS AND NUMBER THEORY

UNIT-1. **16Hrs.**

Basic principles of counting, inclusion and exclusion principles, Pigeonhole principle, advanced counting, Prime numbers, The Fundamental theorem of Arithmetic, The series of Reciprocals of primes, The Euclidean Algorithm. Fermat and Mersenne numbers. Farey series, Farey dissection of the continuum, Irrational numbers-Irrationality of m^{th} root of N, e and π.

UNIT-2. **16Hrs.**

Arithmetical Functions – The Mobius function, The Euler's function and Sigma function, The Dirichlet product of Arithmetical functions, Multiplicative functions. Averages of Arithmetical functions – Euler summation formula, Some elementary asymptotic formulas, The average orders of $d(n)$, $\sigma(n)$, $\varphi(n)$, $\mu(n)$.

UNIT-3. **16Hrs.**

Partitions-Partitions of numbers, the generating function of $p(n)$, other generating functions, Two Theorem of Euler, Jacobi's triple product identity, its proof and its applications.

UNIT-4. **16Hrs.**

Continued fractions - Finite continued fractions, Convergent of a continued fraction, Continued fractions with positive quotients. Simple continued fractions, The representation of an irreducible rational fraction by a simple continued fraction. The continued fraction algorithm and Euclid's algorithm. The difference between the fraction and its convergent, Infinite simple continued fractions, the representation of an irrational number by an infinite continued fraction, Equivalent numbers and periodic continued fractions, some special quadratic surds.

TEXT BOOKS

1. G. H. Hardy and E. M. Wright - An introduction of Topology of Numbers.
2. G. E. Andrews - Encyclopedia of Mathematics and its applications.

REFERENCE BOOKS

1. Niven and Zuckarman: Elementary Number Theory.
2. Bruce C Berndt: Ramanujan's notebooks, Volumes 1 to 5.
3. T. M. Apostol: Introduction to Analytic Number Theory, Narosa Pub. House, New Delhi.

SPT- 2.5(B): OPERATION RESEARCH

UNIT- 1. **16Hrs.**

Revised Simplex Method, Parametric Linear Programming, Linear Fractional Programming, Duality Theorem, Dual Simplex Methods, Post-Optimal Analysis.

UNIT- 2. **16Hrs.**

Integer Programming Problems , Solutions methods of integer programming problem, Branch and Bound Technique, Cutting plane algorithm, game theory, games without saddle point, mixed strategy, algebraic method, graphical method, dominance property, solution of a game by L.P. method.

UNIT- 3. **16Hrs.**

Introduction to Transportation Problem, Initial Basic Feasible solution, Moving towards Optimality, Degeneracy in Transportation Problems, Unbalanced Transportation Problem, Assignment Problems, Job Sequencing.

UNIT-4. **16Hrs.**

Elementary queuing and inventory models. Steady-state solutions of Markovian queuing models: M/M/1, M/M/1 with limited waiting space, M/M/C, M/M/C with limited waiting space, M/G/1.

Non Linear programming problems, Necessary and sufficient conditions for extrema, Constrained extremal problems, Kuhn Tucker conditions, Quadratic Programming**.** Dynamic Programming, Solution of LPP by Dynamic programming.

TEXTBOOKS

1. Hamdy A Taha: Operations Research, Prentice Hall of India, 1995.
2. KantiSwarup, P. K. Gupta, ManMohan: Operations Research, Sultan Chand & Sons, 1995.

REFERENCE BOOKS

1. G Hadley: Linear Programming, Narosa Publishing House, 2002.
2. K. V. Mittal and C. Mohan: Optimization Methods in Operation Research & System Analysis, New Age Publishers, 1996.

OEPT-2.6.1: FOUNDATIONS OF MATHEMATICS

UNIT-1. **16Hrs.**

Brief History of Mathematics.

Number Theory: Natural numbers, integers, Real numbers, GCD, LCM, Prime numbers. Surds, Indices, Logarithms, Progressions, Arithmetic Progression, Geometric Progression, Harmonic Progression.

UNIT-2 **16Hrs.**

Set Theory: Operations of Union, Intersection, Complementation.

Relations & Functions: Types of relations One-one, onto, Many-one functions, graphs of functions.

Mathematical Logic: Propositions, logical connectives, Methods of proofs.

UNIT-3 **16Hrs.**

Quantitative Aptitude: Arithmetic Ability, Percentage, Profit and Loss, Ratio and Proportion, Time and Work, Partnership, Simple and Compound Interest, Volume surface and area, Stocks and Shares, Bankers Discount, Tabulation, Bar graph, Pie graph, Line graphs.

UNIT-4 **16Hrs.**

Frequency distribution, Measures of central tendency, Measures of dispersion, Moments, Curve fitting, y=a+bx, y=a+bx+cx^2, $y = a^x$, Correlation and Regression.

TEXT BOOKS

1. Kolman and Busby: Discrete Mathematics , PHI
2. R. S. Agarawala: Quantitative Aptitude, S. Chand & Co.
3. S. L. Loney: The Elements of Coordinate Geometry, London Macmillan & Co.
4. S. L. Loney: Plane Trigonometry, Reem Publications Pvt. Ltd.

REFERENCE BOOKS

1. B. S. Grewal: Higher Engineering Mathematics, 36th Ed., Khanna Pub.
2. S. Lipschutz and M. Lipson: Theory and Problems of Discrete Mathematics. Schaum Series. 2nd Ed. Tata McGraw Hill.

OEPT-2.6.2 : Scilab - PROGRAMMING LAB I

LIST OF PROGRAMS:

1. Program to accept three integers and print the largest among them.
2. Program to check whether the integer is even or odd and also positive or negative.
3. Program to find square root and cube root.
4. Program to find roots of quadratic equation.
5. Program to convert binary number to decimal number and vice versa.
6. Program to calculate largest and second largest element of an array.
7. Program to find average and percentage.
8. Program to find mean, mode and median.
9. Program to calculate factorial of a number.
10. Program to find permutation and combination.
11. Program to print Fibonacci numbers.
12. Program to test whether the number is prime or not.
13. Program to test whether the number is perfect or not.
14. Program to find profit, loss, percentage profit and percentage loss.
15. Program to find simple and compound interest.
16. Program to find surface area and volume geometric objects.

TEXT BOOKS

1. V. Rajaraman, Fundamentals of Computers, PHI, 1991.
2. B. S. Gottfried, Programming with C, Tata McGraw Hill, Schaum's Outlines, 1998.

REFERENCE BOOKS:

1. E. Balagurusamy, Programming in ANSI – C, Tata McGraw Hill Pub. Co. 1992.
2. B. W. Kernighan and D. M. Ritchie, The C programming Language, PHI, 1998.

THIRD SEMESTER M.Sc. MATHEMATICS (CBCS)

CPT-3.1: TOPOLOGY II

UNIT-1. **16Hrs.**

The axioms of countability: First axiom space, second countable space, separability and the Lindelof property and their equivalence for metric spaces, the product topology, the metric topology, the quotient topology, product invariant properties for finite products, Projection maps.

UNIT-2. **16Hrs.**

Separation axioms: T_0–space and T_1-spaces–definitions and examples, the properties are hereditary and topological, characterisation of T_0 - and T_1 –spaces, T_2- space, unique limit for convergent sequences, Regularity and the T_3–axiom. characterisation of regularity, metric spaces are T_2 and T_3.

UNIT-3. **16Hrs.**

Complete regularity, normality and the T_4 - axiom, metric space is T_4, compact Hausdorff space and regular Lindelof spaces are normal, Urysohn's lemma, Tietze's Extension Theorem, complete normality and the T_5 –axiom, metrizability, Urysohn's metrization theorem, Tychnoff theorem, Stone-Cech compactification, local finiteness, paracompactness, normality of a paracompact space.

UNIT-4. **16Hrs.**

Homotopy: homotopy, product of path homotopy, the fundamental group, simply connected space. Covering space, slices, covering map, local homeomorphism, the fundamental group of circles, lifting.

TEXT BOOKS

1. J. R. Munkres, Topology, Second Edition, Prentice Hall of India, 2007
2. W.J. Pervin : Foundations of General Topology - Academic Press, 1964.

REFERENCE BOOKS

1. G. F. Simmons: Introduction to Topology and Modern Analysis – Tata Mc Graw Hill, 1963.
2. J. Dugundji: Topology - Prentice Hall of India, 1975.
3. Allen Hatcher: Algebraic topology, 2005.

CPT-3.2: LINEAR ALGEBRA

UNIT-1. **16Hrs.**

Linear Transformations: Regular and Singular of Linear Transformations. Rank and nullity, Dual Spaces. Matrices of Linear transformation, Composition of Linear Transformations and Matrix Multiplication, Invertibility and Isomorphisms, the Change of Coordinate Matrix, Rank of a Matrix, Systems of Linear Equations.

UNIT-2. **16Hrs.**

Determinants: Properties of Determinants, Cramer's rule. Eigenvalues and Eigenvectors, Diagonalizability, Cayley-Hamilton Theorem. Inner Products and Norms, Gram-Schmidt Orthogonalization Process and Orthogonal Complements, Spectral Theorem.

UNIT-3. **16Hrs.**

Types of Linear Transformation, Hermitian, Unitary and Normal Transforms.

Canonical Forms: Invariant subspaces, Triangular Form, Nilpotent canonical form, Jordan canonical form and Rational Canonical forms, Bilinear Form, Real Quadratic forms, The Sylvester Law of Inertia.

UNIT-4. **16Hrs.**

Extension fields: Adjunction of roots, finite and algebraic extensions. Transcendental extensions, Splitting fields, finite fields. Separable and inseparable extensions, perfect and imperfect fields, theorem on primitive elements.

TEXT BOOKS

1. S. Friedberg, A. Insel, and L. Spence: Linear Algebra, Fourth Edition, PHI, 2009.
2. Jimmie Gilbert and Linda Gilbert: Linear Algebra and Matrix Theory, Academic Press, An imprint of Elsevier.
3. D. S. Dummit and R. M. Foote: Abstract Algebra, John Wiley and Sons, 1999
4. I.N.Herstein: Topics in Algebra, 2nd Edition, Vikas Pub., 1976.

REFERENCE BOOKS

1. M. Artin: Algebra, Prentice Hall of India, 1991.
2. Joseph Rotman: Galois Theory, Universitext, Springer, 1998.
3. J.B.Fraleigh: A first course in Algebra, 3rd Ed., Narosa,
4. Hoffman and Kunze: Linear Algebra, 2ND Ed. Prentice-Hall of India, 1978.
5. P. R. Halmos: Finite Dimensional Vector Space, D. Van Nostrand, 1958.
6. S. Kumeresan: Linear Algebra- A Geometric approach, Prentice Hall India, 2000.

CPT- 3.3: COMPLEX ANALYSIS

UNIT-1. **16Hrs.**

Complex integration: Contour integrals, antiderivatives, Cauchy-Goursat theorem for simply and multiply connected domains, winding numbers, Cauchy integral formula, derivatives of analytic functions, Moreva's theorem, Cauchy's inequality, Liouville's theorem and fundamental theorem of algebra, maximum modulli of functions, Schwartz lemma.

UNIT-2. **16Hrs.**

Power series, radius of convergence of a power series, uniform convergence of power series, power series representation of analytic functions, Taylor's series, Laurent series, Residues, classification of singularities, residues at poles, zeros and poles of order m, conditions under which $f(z) \equiv 0$, behavior of $f(z)$ at infinity, analytic continuation.

UNIT-3. **16Hrs.**

Evaluation of definite integrals involving sines & cosines, evaluation of improper integrals and Cauchy's principal value, integrals involving rational functions, integrals involving sines and cosines, integrals along indented contours, integration along branch cut, Integration along rectangular contours.

UNIT-4. **16Hrs.**

Entire and Meromorphic functions, Argument principle and Rouche's theorem, Hadamard three circle theorem, harmonic functions, Poisson integral formula, infinite products, entire functions, Weirstrauss factorization theorem, Phragman - Lindelof theorem, Jensen's formula.

TEXTBOOKS:

1. J. W Brown and R. V. Churchill, Complex Variables and Applications, McGraw Hill, 1996
2. H. S. Kasana, Complex Variables: Theory and Applications, PHI, 2000.
3. J. B Conway, Functions of one Complex Variable, Narosa, 1987.

REFERENCE BOOKS:

1. L. V. Ahlfors, Complex analysis, McGraw Hill, 1966
2. S. Ponnusamy, Functions of Complex Variables, Narosa Pub.
3. S. Lang, complex Analysis, 3rd ed. Springer, 1993

CPT-3.4: FLUID MECHANICS

UNIT-1. **16Hrs.**

Motion of inviscid fluids: Euler's equation of motion, Bernoulli's equation in standard forms, Illustrative examples of theorems. Pressure at a point in a fluid at rest and that in motion. Vortex motion, Circulation, Kelvin's circulation theorem, Kelvin's Minimum Energy Theorem, Illustrative examples. Helmhotzvorticity equation, Permanance of vorticity and circulation.

UNIT- 2. **16Hrs.**

Two dimensional flow of inviscid fluids: Meaning of two-dimensional flow. Examples. Sream function. Complex potential, source and sinks in two dimensions, complex potential due to a source, Doublet in two dimensions, Images, Image of a doublet with respect to a line, The Milne-Thomson circle theorem, Blasius theorem and applications.

UNIT-3. **16Hrs.**

Motion of viscous fluids: Stress & strain components in a real fluid. Relation between stress & strain components. Geometrical interpretation of the components of strain. Thermal conductivity of fluid, Navier-stokes equation & energy equation. Physical significances of non- dimensional numbers. Standard applications of Navier-Stokes equation.

UNIT-4. **16Hrs.**

Boundary layer concepts: Prandtl's boundary layer concept. Derivation of two dimensional boundary layer equation for velocity by order magnitude approach. Boundary layer flow past a fiat plate Blasius solution, Von-Karman momentum integral equation. Gas Dynamics: Compressible fluid flows, Standard forms of equations of State, Speed of sound in a gas, Equations of motion of Non-Viscous and Viscous Compressible flows, Illustrative examples.

TEXT BOOKS

1. G. K. Batchelor: An Introduction to Fluid Mechanics, Foundation Books, New Delhi,1994.
2. F. Chorlton: Text book of Fluid Dynamics, CBS publishers, Delhi, 1985.
3. S. W. Yuan: Foundations of Fluid Mechanics, PHI Pvt. Ltd., New Delhi, 1976.
4. R. K. Rathy: An Introduction to Fluid Dynamics, Oxford and IBM Pub. Co., New Delhi,1976.

REFERENCES

1 L. D. Landau and E. M. Lipschitz: Fluid Mechanics, Pergamon press, London, 1995.

2 H. Schlichting: Boundary Layer Theory, McGraw Hill Book Company, New York,1979.

3 A.D.Young: Boundary Layers AJAA Education series, Washington DC 1989.

4 L. Popenhead: Laminar Boundary Layer, Clearan Don press Oxford.

SPT- 3.5(A): NONLINEAR DYNAMICS

Recapitulation: History of dynamics**,** importance of being nonlinear, linearity and nonlinearity in physics and the other sciences.

UNIT-1. **16Hrs.**

Non-linear equations, Autonomous systems, Phase plane, Critical points, stability and paths of Linear and Non-Linear systems, Liapunov direct method, limit cycles and periodic solution, Conservative and reversible system, Poincare Bendixion theorem, Existence and uniqueness of solutions.

UNIT-2. **16Hrs.**

Discrete Systems, Examples of discrete systems, some terminology, linear discrete systems, nonlinear discrete systems, quadratic maps.

UNIT-3. **16Hrs.**

Introduction of Bifurcations. Saddle-node bifurcation, transcritical bifurcation, Pitchfork bifurcation, Hopf bifurcation, global bifurcation.

UNIT-4. **16Hrs.**

Chaos. Lyapunov exponents, chaotic attractors, need for chaos control, the OGY method, Introduction to fractals.

Examples of chaotic systems: Lorenz Equation, Rossler Equation, Forced Pendulum and Duffing oscillator, Chua's Circuit, Logistic map.

TEXT BOOKS

1. J. Berry and Arnold: Introduction to Non-Linear Systems, Great Britain 1996.
2. S. H. Strogatz: Non Linear Dynamics and Chaos, Addision Wesley, Pub. Co., USA, 1994.
3. E. A. Coddington: Theory of Ordinary Differential Equations, McGraw-Hill, 1955.
4. S. Wiggins: Introduction to Applied Non-Linear Dynamical systems and Chaos. TAM, Springer-Verlag, Vol-2 NewYork, 1990.
5. M. W. Hirsch, S. Smale, and R. L. Devaney: Differential Equations, Dynamical Systems and an Introduction to Chaos, Elsevier, 2004.
6. M. Lakshmanan and S. Rajasekar: Nonlinear Dynamics, Integrality, Chaos and Patterns, Springer Intrn. Ed., 2009.
7. G. B. Whitham: Linear and Nonlinear Waves, John Wiley & Sons, New York.

REFERENCE BOOKS

1. Shankar Sastry: Nonlinear Systems-Analysis, Stability and Control, Springer, 1999.
2. M Vidyasagar: Nonlinear Systems analysis, Prentice Hall, new Jersey, 1993.
3. S. Wiggins: Introduction to Applied Non-Linear Dynamical systems and Chaos. TAM, Springer-Verlag, Vol-2 NewYork, 1990.
4. M. Lakshmanan and S. Rajasekar: Nonlinear Dynamics,Integrality, Chaos and Patterns, Springer Intrn. Ed., 2009.

SPT- 3.5(B): DESIGN AND ANALYSIS OF ALGORITHMS

UNIT-1. **16Hrs.**

Introduction to Algorithms: Meaning of space and time complexity, illustrations with simple examples. Introduction to growth functions, Asymtotic notation: Big-oh, little-oh, big-omega, littleomega, theta functions, illustrations. Inter-relations between different growth functions and comparison. Basic data structures: Lists, Stacks, Queues, Trees, Graphs, Heaps, examples and applications.

UNIT-2. **16Hrs.**

Searching, Sorting and Selection: Selection search, binary search, insertion sort, merge sort, quick sort, radix sort, counting sort, heap sort. Median finding using quick select, Median of Medians, Graph Algorithms: Depth-First search, breadth-first search, backtracking, branch-and-bound, etc.

UNIT-3. **16Hrs.**

Greedy Algorithms: General characteristics of greedy algorithms, Greedy scheduling algorithms, Dijkstra's shortest path algorithms (graphs and digraphs), Kruskal's and Prim's minimum spanning tree algorithms.

UNIT-4. **16Hrs.**

Dynamic Programming: Elements of dynamic programming, the principle of optimality, the knapsack problem, dynamic programming algorithms for optimal polygon triangulation, optimal binary search tree, longest common subsequence, chained matrix multiplication, all pairs of shortest paths (Floyd's algorithm). Introduction to NP-completeness, Polynomial time reductions, verifications, verification algorithms, classes P and NP, NP-hard and NP-complete problems.

TEXT BOOKS

1. T. Cormen, C. Leiserson, R. Rivest & C. Stein, Introduction to Algorithms, MIT Press, 2001.
2. David Harel, Algorithms, The spirit of Computing, Addison-Wesley, Langman, Singapore, Pvt. Ltd. India, 2000.

REFERENCE BOOKS

1. Baase S and Gelder, A.V, Computer Algorithms, Addition - Wesle Langman Singapore, Pvt. Ltd. India, 2000.
2. Garey, M.R. and Johnson, D.S, Computers and Intractability: A Guide to the Theory of NPCompleteness, W. H. Freeman, San Francisco, 1976.
3. R. Sedgewick, Algorithms in C++, Addison- Wesley, 1992.

SPT- 3.5(C): MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

UNIT-1. **08Hrs.**

Introduction, Machine learning definition, importance of machine learning, machine learning framework, types of machine learning, relation to other fields, examples of machine learning applications, designing a learning system, issues in machine learning.

UNIT-2. **08Hrs.**

Introduction to Supervised Learning, Decision tree-based classifier, Bayesian theory-based classifier, Neural network-based classifier, Nearest neighbor classifier, Support vector classifier, performance evaluation. Introduction to Unsupervised Learning, Clustering methods.

UNIT-3. **08Hrs.**

Criteria functions for Clustering, Similarity measures, Component analysis, Low dimensional analysis and multidimensional scaling

UNIT-4. **08Hrs.**

Additional topics, Reinforcement learning, Genetic algorithms, Analytical learning, Ensemble of classifiers, Design and analysis of machine learning experiments.

TEXT BOOKS

1. Introduction to Machine Learning by Alex Smola and S.V.N. Viswanathan, Cambridge UniversityPress.
2. Understanding Machine Learning: From Theory to Algorithms by Shai Shalev-Schwartz and ShaiBen-David Published 2014 by Cambridge University Press.

REFERENCE BOOKS

1. Machine Learning: a Probabilistic Perspective by Kevin Patrick Murphy, MIT Press, March2014.

SPP- 3.5(C) MACHINE LEARNINGAND ARTIFICIAL INTELLIGENCE LAB

Minimum System requirements:

- Processors: Intel Atom® processor or Intel® Core™ i3 processor.
- Disk space: 1 GB.
- Operating systems: Windows* 7 or later, macOS, and Linux.
- Python* versions: 2.7.X, 3.6.X.,3.8.X

LIST OF PROGRAMS

1. Write a Program to Implement Breadth First Search.
2. Write a Program to Implement Depth First Search.
3. Write a program to implement Hill Climbing Algorithm.
4. Write a program to implement A* Algorithm.
5. Write a program to implement Tic-Tac-Toe game..
6. Implementation of Python basic Libraries such as Math, Numpy and Scipy.
7. Implementation of Python Libraries for ML application such as Pandas and Matplotlib.
8. Creation AND Loading different datasets in Python.
9. Write a python program to compute Mean, Median, Mode, Variance and Standard Deviation using Datasets.
10. Implementation of Find S Algorithm.
11. Implementation of Candidate elimination Algorithm.
12. Write a program to implement simple Linear Regression and Plot the graph.

OEPT-3.6.1: ELEMENTS OF APPLIED MATHEMATICS

UNIT-1. **16Hrs.**

Graphs of functions. Limits- Definitions and Examples. Continuity: Continuous and Discontinuous functions, Differentiation: Rules of differentiation, Maximum and minimum of function of two variables. Integration: Definition, Rules of integration, Definite and Indefinite integration, some applications.

UNIT-2. **16Hrs.**

Rolle's Theorem, Lagrange's Theorem, Cauchy's Mean Value Theorem, Taylors Theorem, Maclaurin's form (Without proofs of theorems, only problems). Partial differentiation of Homogeneous functions, Eulers Theorem (No proof), Total differentiations, Errors and Approximations. First order Ordinary Differential Equations and their Applications.

UNIT-3. **16Hrs.**

Matrix Algebra: Definition, types of matrix, transpose of a matrix, determinants, properties of determinants, co-factors matrix, Cramer's Rule, adjoint matrix, inverse of a matrix and elementary row operations, singular & non-singular matrix, Methods of solving system of linear equations, Eigen values and eigen vectors.

UNIT-4. **16Hrs.**

Probability of events, conditional probability, Baye's theorem, Distribution function- Binomial, Poission, Normal distribution.

TEXT BOOKS

1. B. S. Grewal: Higher Engineering Mathematics, 36th Ed., Khanna Pub.
2. Seymour Lipschutz: Probability, Schaum' s series.
3. V K Kapoor and S C Gupta: Fundamentals of Mathematical Statistics, S Chand Publication.

REFERENCE BOOKS

1. B. V. Ramana: Higher Engineering Mathematics, Tata Mc Graw Hill.
2. Shanti Narayan: Matrices:, S Chand.

OEPP-3.6.2 : Scilab- PROGRAMMING LAB II

LIST OF PROGRAMS:

1. Write a program to find partial derivatives of functions of two or three variables
2. Write a program to evaluate double and triple integration.
3. Write a program to find Taylor and Maclaurin series of functions.
4. Write a program to find the transpose of a matrix.
5. Write a program to find the addition of two matrices.
6. Write a program to find the product of two matrices.
7. Write a program to find trace and norm of a matrix.
8. Write a program to check if a matrix is symmetric or not.
9. Write a program to construct identity, scalar matrix and diagonal matrix.
10. Write a program to compute the determinant of a 2x2 and 3x3 matrix.
11. Write a program to check whether the matrix is singular or non singular.
12. Write a program to compute the rank of a matrix.
13. Write a program to solve a system of linear equations using Cramer's rule.
14. Write a program to find characterstic equation of the given matrix.
15. Write a program to compute the eigenvalues and eigenvectors of a matrix.

TEXT BOOKS

1. V. Rajaraman, Fundamentals of Computers, PHI, 1991.
2. B. S. Gottfried, Programming with C, Tata McGraw Hill, Schaum's Outlines, 1998.

REFERENCE BOOKS:

1. E. Balagurusamy, Programming in ANSI – C, Tata McGraw Hill Pub. Co. 1992.
2. B. W. Kernighan and D. M. Ritchie, The C programming Language, PHI, 1998.

FOUTH SEMESTER M. Sc. MATHEMATICS (CBCS)

CPT-4.1: MEASURE AND INTEGRATION

Recapitulation: Riemann integration, Sequence and series of functions, uniform convergence (Without Proofs of Theorems). **4hrs.**

UNIT-1. **15hrs.**

Ring of a set, σ-ring of sets, algebra of sets, sigma algebras, open subsets of the real line. Fer and Ger sets, Borel sets, Lebesgue measure, Outer measure, relation between Lebesgue outermeasure and length of an interval, Countable sub-additivity of Lebesgue outer measure,translation invariance.

UNIT-2. **15hrs.**

Measurable sets: algebra of measurable sets, the class of measurable sets as algebra, the measure of the intersection of decreasing sequence of measurable sets, a non-measurable set. Measurable functions; Measurability of continuous functions, almost everywhereproperty, Characteristic functions, Simple functions, Littlewood's three Principles and applications.

UNIT-3. **15hrs.**

Lebesgue Integral; Lebesgue integral of a bounded function defined on a closed interval, Lebesgue integral of a non-negative function, Comparison with the Riemann integral, Lebesgue integral of a measurable function, Properties of Lebesgue integral, Convergence Theorems and Lebesgue integral, the Bounded convergence theorem, Fatou's Lemma, Monotone convergence theorem, general Lebesgue integral, Lebesgue dominated convergence theorem.

UNIT-4. **15hrs**

Differentiation of monotone functions,g Vitali covering lemma, Lebesgue theorem, L_p spaces, Holder and Minkowski inequalities. Convergence and completeness, Riesz – Fischer Theorem. Bounded linear functional, Riesz representation theorem and illustrative examples. Measure spaces, Signed measures, the Radon Nikodyn theorem.

TEXT BOOKS

1. H. L. Royden: Real Analysis, Prentice Hall, 3rd Ed.,
2. G. de Barra: Measure Theory and Integration, Wiley Eastern Limited.
3. Inder K. Rana: An Introduction to Measure and Integration, Narosa, 1997.

REFERENCE BOOKS

1. Paul R. Halmos. Measure theory D, van. Nostrand Co. Inc, NY & Affiliated East-west pressesPvt., Ltd, New Delhi, 1966.
2. Harold Wodom: Lectures on Measure &Integration, Van Nostrand Reinhold Co., New York.
3. K.P.Gupta, Measure Theory, Krishna Prakashan Media, Pvt. Ltd.II, Meerut, India.

CPT-4.2: FUNCTIONAL ANALYSIS

UNIT-1. **16Hrs.**

Normed linear space: examples and theorems. Holder's inequality. Minkowski's inequality. Banach Spaces: examples and theorems. Quotient Spaces. Convexity of the closed unit sphere of a Banach Space. Linear transformations on a normed linear space and characterization of continuity of such transformations.

UNIT-2. **16Hrs.**

The set $B(N , N')$ of all bounded linear transformations of a normed linear space N into normed linear space N'. Linear functionals, The conjugate space N*. The natural imbedding of N into N**. Hahn-Banach Theorem and its consequences, Projections on a Banach space. The Open Mapping Theorem, The Closed Graph Theorem, Uniform Boundedness Theorem. The Conjugate of an Operator, Properties of Conjugate Operator.

UNIT-3. **16Hrs.**

Hilbert Spaces, Definition and Examples, Schwarz's inequality. Parallelogram Law, Polarization identity. Convex sets, a closed convex subset of a Hilbert Space contains a unique vector of the smallest norm Orthogonal sets in a Hilbert space. Bessel's inequality. Orthogonal complements, complete orthonormal sets, Orthogonal decomposition of a Hilbert space.

UNIT-4. **16Hrs.**

The conjugate space H* of a Hilbert space H. Representation of a functional f as f(x) = (x, y) with y unique. The Hilbert space H*. Interpretation of T* as an operator on H. The adjoint operator T - T* on B (H). Self-adjoint operators, Positive operators. Normal operators. Unitary operators and their properties. Projections on a Hilbert space, properties of orthogonal projections on Hilbert spaces Finite dimensional spectral theorem.

TEXT BOOKS

1. G. F. Simmons: Introduction to Topology and Modern Analysis, McGraw-Hill Ed.
2. A. E. Taylor: Introduction to Functional Analysis, Wiley, New York, 1958.
3. B. V. Limaye: Functional Analysis (Wiley Eastern).

REFERENCE BOOKS

1. G. Backman and L. Narici: Functional Analysis (Academic).
2. P.R. Halmos: Finite dimensional vector paces, Van Nostrand, 1958.
3. J. B. Conway: A Course in Functional Analysis, GTM, Vol. 96, Springer, 1985.
4. E. Kreyszig : Introduction to Functional Analysis with Applications, John Wiley & Sons

CPT-4.3: PROBABILITY & STATISTICS

UNIT-1. **16hrs**

Probability, Classical, relative frequency and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Baye's theorem and independence, Random variables, discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, moment generating function, Chebyshev's inequality.

UNIT-2. **16hrs**

Morkov chains with finite and countable state space, classification of states, limiting behavior of n-step transition probabilities, stationary distribution, Poisson and birth-and-death processes, Special distributions, discrete uniform, binomial, geometric, poisson, exponential, gamma, normal distributions, functions of random variable, joint distributions, joint, marginal and conditional distributions, product moments, independence of random variables, bivariate normal distribution

UNIT-3. **16hrs**

Sampling distributions, the central limit theorem, distributions of the sample mean and the sample variance for a normal population, chi-square, t, F and z distributions.

UNIT-4. **16hrs**

Correlation, scatter diagram, Karl Pearson's coefficient of correlation, least square curve fitting, fitting k^{th} degree parabola, probable error of correlation coefficient, rank correlation. Estimation, the method of moments and the method of maximum likelihood estimation, confidence intervals for the mean and variance of normal populations.

TEXT BOOKS

1. S. C. Gupta: Fundamentals of Statistics. Himalaya Publishing House, 1981.
2. Richard A. Johson, Miller and Freunots: Probability and Statistics for Engineers.

REFERENCE BOOKS

1. B. Rosuer: Fundamentals of Biostatistics, Duxbury Thompson Learning, 2000.

CPT- 4.4: MATHEMATICAL METHODS

Recapitulation: Laplace transforms, Inverse Laplace Transforms, Fourier Transforms, Finite Fourier Transforms. **4hrs.**

UNIT-1. **15hrs.**

Integral Transforms and Calculus of Variations: General definition of Integral transforms, Kernels, etc. Z-Transform, Hankel and Mellin transforms, Kernels, etc. Hankel transforms to solve ODEs and PDEs - typical examples. Discrete Orthogonality and Discrete Fourier transform. Wavelets with examples, wavelet transforms.

UNIT-2. **15hrs.**

Integral Equations: Definition, Volterra and Fredholm integral equations. Solution by separable kernel, Neumann' s series resolvent kernel and transform methods, Convergence for Fredholm and Volterra types. Reduction of IVPs BVPs and eigenvalue problems to integral equations, Raleigh Ritz and Galerkin methods.

UNIT-3. **15hrs.**

Asymptotic Methods: Asymptotic expansion of functions, power series as asymptotic series, Asymptotic forms for large and small variables. Asymptotic expansions of integrals; Method of integration by parts (include examples where the method fails), Laplace method andWatson's lemma, method of stationary phase and steepest descent.

UNIT-4. **15hrs.**

Perturbation Methods: Regular and singular perturbation methods, Regular perturbation solution of first and second order differential equations involving constant and variable coefficients Include Duffings equation, Vanderpol oscillator, Introductory examples of boundary layer, matched asymptotic expansion. Applications of differential equations. WKB approximation and solution. Poincare-Lindstedt method.

TEXT BOOKS

1. R.P. Kanwal: Linear integral equations theory and techniques, Academic Press, Ny, 1971.
2. C.M. Bender and S.A. Orszag: Advanced Mathematical Methods for Scientists andEngineers, McGraw- Hill, New York, 1978.

REFERENCE BOOKS

1. H.T. Davis:Introduction to nonlinear differential and integral equations, Dover Pub.1962.
2. A.H. Nayfeh: Perturbation Methods, John Wiley &Sons New York, 1973
3. Don Hong, J. Wang and R. Gardner. Real analysis with Introduction to Wavelets &Applications, Academic Press, Elsevier, 2006.
4. R.V. Churchill: Operational Mathematics, Mc. Graw Hill, New York, 1958
5. I.N. Sneddon – The Use of Integral Transforms, Tata McGraw Hill, New Delhi, 1974.

SPT-4.5(A): MAGNETO HYDRODYNAMICS

UNIT-1. **16hrs.**

Electrodynamics: Electrostatics, Coulomb's law, derivation of Gauss's law, electric potential, dielectrics, polarization, bound charges, Gauss law in the presence of dielectrics, magneto statics, Faraday's law, Ampere's law, vector potential, conservation of charges, electromagnetic units.

UNIT-2. **16hrs.**

Basic equations of MHD, Magnetic induction equation, Lorentz force, MHD approximations, non-dimensional numbers, velocity temperature and magnetic field boundary conditions, electro-magnetic interface conditions.

UNIT-3. **16hrs.**

Hartmann flow, temperature distributions in Hartmann flow, Couette flow, Hagen-Poiseuille flow, Temperature distribution for these flows, concepts in classical MHD.

UNIT-4. **16hrs.**

Alfven waves, cause for Alfven waves, Alfven theorem, equipartition of energy, dissipation of energy by Alfven waves, reflection and transmission of Alfven waves, applications.

TEXT BOOKS

1. V.C. A Ferraro and Plumpton: Introduction to Magnetofluidmechanics, Clarendon Press,1966.
2. David J Griffiths: Introduction to electrodynamics, PHI,1997
3. Allen Jeffrey: Magneto hydrodynamics

REFERENCE BOOKS

1. Sutton and Sherman: Magneto hydrodynamics, McGraw Hill, 1965.

SPT-4.5(B): DIFFERENTIAL GEOMETRY

Recapitulation: Elements of Calculus, Linear Algebra and Geometry. **4hrs.**

UNIT-1. **15hrs.**

Calculus on Euclidean Space, Directional derivatives and their properties. Curves in E^3. Velocity and speed of a curve. Reparametrization of a curve. 1-forms and Differential forms. Wedge product of forms. Mappings of Euclidean spaces. Derivative map.

UNIT-2. **15hrs.**

Frame Fields, Arc length parametrization of curves. Vector field along a curve. Tangent vector field, Normal vector field and Binormal vector field. Curvature and torsion of a curve. The Frenet formulas Frenet approximation of unit speed curve and Geometrical interpretation. Properties of plane curves and spherical curves. Arbitrary speed curves. Covariant derivatives and covariant differentials. Connection forms. Attitude Matrix. Isometries of E^3.

UNIT-3. **15hrs.**

Calculus on a Surface, Coordinate patch. Monge patch. Surface in E^3. Special surfaces-sphere, cylinder and surface of revolution. Parameter curves, velocity vectors of parameter curves, Patch computation. Parametrization of surfaces - cylinder, surface of revolution and torus. Tangent vectors, vector fields and curves on a surface in E^3. Directional derivative of afunction on a surface of E^3. Differential forms and exterior derivative of forms on surface of E^3, Pull back functions on surfaces of E^3.

UNIT-4. **15hrs.**

Shape Operators, Shape operators of sphere, plane, cylinder and saddle surface. Normal curvature, Normal section. Principal curvature and principal direction. Umbilic points of a surface in E^3. Euler's formula for normal curvature of a surface in E^3. Gaussian curvature, Mean curvature and Computational techniques for these curvatures. Minimal surfaces, Special curves in a surface of E^3 - Principal curve, geodesic curve and asymptotic curves.

TEXT BOOKS

1. Barrett O' Neil: Elementary Differential Geometry. Academic Press, New York & London, 1966

2. T. J. Willmore: An introduction to Differential Geometry. Clarendon Press,Oxford 1959.

REFERENCE BOOKS

1. D. J. Struik: Lectures on Classical Differential Geometry, Addison Wesley,Reading Mass, 1961.

2. NirmalaPrakassh: Differential Geometry- AnIntegrated approach. Tata McGraw-Hill, NewDelhi, 1981.

SPT-4.5(C): GALOIS THEORY

UNIT-1. **16hrs**

Algebraically closed fields and algebraic closures, The existence of an algebraic closure, The basic isomorphisms of algebraic field theory, Automorphisms and fixed fields, The Frobeniusautomorphism, The isomorphism extension theorem.

UNIT-2. **16hrs**

The index of a field extension, Splitting fields, Separable extensions, Perfect fields, Normal extensions.

UNIT-3. **16hrs**

Galois theory - the main theorem of Galois theory, Galois groups over finite fields, Symmetric functions, Cyclotomic extensions, Constructible numbers.

UNIT-4. **16hrs**

The impossibility of certain geometrical constructions, constructible polygons, Subnormal and normal series, the Jordan - Holder theorem, Radical extensions and solution of equation by radicals, the insolvability of the quintic.

TEXT BOOKS

1. J. B. Fraleigh: A First Course in Abstract Algebra, Narosa Publishing House.
2. 5. Joseph A. Gallian: Contemporary Abstract Algebra, Narosa Publishing House, 4th Ed.
3. D. S. Dummit and R. M. Foote: Abstract Algebra, John Wiley and Sons, 1999.

REFERENCES:

1. Ian Steward : Galois Theory, Chapman and Hall.
2. Joseph Rotman: Galois Theory, Universitext Springer, 1998.
3. Michael Artin: Algebra, Prentice-Hall of India, New Delhi.
4. I. N. Herstein: Topics in Algebra, Vikas Publishing House, New Delhi.
5. N. S. Gopalakrishnan: University Algebra, New Age International, 2nd Ed.,

SPT-4.5(D): ADVANCED GRAPH THEORY

Recapitulation: Elementary concepts of graph theory, Cut- vertex, Bridge, Blocks, Vertex- connectivity, Edge-connectivity (no proofs of theorems). **4hrs.**

UNIT-1. **15hrs.**

Planarity, Plane and Planar graphs, Euler Identity, Non planar graphs, Maximal planar graph Outer planar graphs, Maximal outer planar graphs, Characterization of planar graphs, Geometric dual, Crossing number.

UNIT-2. **15hrs.**

Colorings, Vertex Coloring, Color class, n-coloring, Chromatic index of a graph, Chromatic number of standard graphs, Bichromatic graphs, Colorings in critical graphs, Relation between chromatic number and clique number/independence number/maximum degree, Edge coloring, Edge chromatic number of standard graphs Coloring of a plane map, Four color problem, Five color theorem, Uniquely colorable graph. Chromatic polynomial.

UNIT-3. **15hrs.**

Matchings and factorization: Matching - perfect matching, augmenting paths, maximum matching, Hall's theorem for bipartite graphs, the personnel assignment problem, a matching algorithm for bipartite graphs, Factorizations, 1-factorization, 2-factorization. Partitions-degree sequence, Havel's and Hakimi algorithms and graphical related problems.

UNIT-4. **15hrs.**

Domination concepts and other variants, Dominating sets in graphs, domination number of standard graphs, Minimal dominating set, Irredundant set, Bounds of domination number in terms of size, order, degree, diameter, covering and independence number, Domatic number, Independence domination number, Total domination number, Connected domination number.

TEXT BOOKS

1. F. Harary: Graph Theory, Addison -Wesley,1969
2. G. Chartrand and P. Zhang: Introduction to Graph Theory. McGraw-Hill Intrn. Ed., 2005.
3. J. A. Bondy and V.S.R.Murthy: Graph Theory with Applications, Macmillan, London.
4. D. Cvetkovic, M. Doob, I. Gutman and A. Torgasev, Recent Results in Theory of GraphSpectra, Annulus of Discrete Mathematics, No.36. Elsevier Science, Pub.BV.1991.
5. Theory of domination by V.R Kulli.

REFERENCE BOOKS

1. N.Deo: Graph Theory: PHI Pvt. Ltd. New Delhi, – 1990
2. T.W. Haynes, S.T. Hedetneime and P. J. Slater: Fundamental of Domination in graphs,Marcel Dekker. Inc. New York.1998.
3. J. Gross and J. Yellen: Graph Theory and its application, CRC Press LLC, BR, Florida,2000.

THEORY QUESTION PAPER PATTERN

Duration of Examination: 3 hrs **Max. Marks** = 70

Answer any **five** questions.

1.	Descriptive type question (From Unit-1)	14
2.	Descriptive type question (From Unit-1)	14
3.	Descriptive type question (From Unit-2)	14
4.	Descriptive type question (From Unit-2)	14
5.	Descriptive type question (From Unit-3)	14
6.	Descriptive type question (From Unit-3)	14
7.	Descriptive type question (From Unit-4)	14
8.	Descriptive type question (From Unit-4)	14

Note: Equal weightage will be given to each unit while preparing the question paper. Questions from 1to 8 may contain subquestions.

PRACTICAL BASED THEORY QUESTION PAPER PATTERN

Duration of Examination: 2 hrs **Max. Marks** = 35

Note: Answer any **five** questions.

1.	Descriptive type question (From Unit-1)	7
2.	Descriptive type question (From Unit-1)	7
3.	Descriptive type question (From Unit-2)	7
4.	Descriptive type question (From Unit-2)	7
5.	Descriptive type question (From Unit-3)	7
6.	Descriptive type question (From Unit-3)	7
7.	Descriptive type question (From Unit-4)	7
8.	Descriptive type question (From Unit-4)	7

Note: Equal weightage will be given to each unit while preparing the question paper. Questions from 1to 8 may contain subquestions.

PRACTICAL QUESTION PAPER PATTERN

Duration of Examination: 3 hrs **Max. Marks** = 35

1.	Experiments, Spotting, Demonstrations & Executions.	**25 Marks**
2.	Records (which includes Logic, Algorithm, Flowchart, Programs & sample outputs) and submission.	**5 Marks**
3.	Viva-voce	**5 Marks**
