BANGALORE UNIVERSITY

DEPARTMENT OF MATHEMATICS

Syllabus
For
M.Sc., Mathematics
CBCS (Semester) Y2K17 Scheme

Revised with effect from
Academic Year 2017-2018

Scheme of Instruction and Examination:

I SEMESTER								
Subjects	**Papers**		**Instruction hrs/week**	**Duration of Exam(hrs)**	**Marks**			**Credits**
					IA	**Exam**	**Total**	
Core Subject	**Theory**	**M101T :** Algebra-I	4	**3**	30	70	100	4
		M102T : Real Analysis	4	3	30	70	100	4
		M103T : Topology-I	4	3	30	70	100	4
		M104T: Ordinary Differential Equations	4	3	30	70	100	4
		M105T: Discrete Mathematics	4	3	30	70	100	4
	Practicals	**M106P :** Maxima practicals based on paper M105T	2	3	15	35	50	1
Soft Core	**Theory**	**M107SC:** Mathematical Analysis	3	3	30	70	100	3
Total of Credits for I Semester								**24**

II SEMESTER								
Subjects	**Papers**		**Instruction hrs/week**	**Duration of Exam(hrs)**	**Marks**			**Credits**
					IA	**Exam**	**Total**	
Core Subject	**Theory**	**M201T :** Algebra - II	4	**3**	30	70	100	4
		M202T : Complex Analysis	4	3	30	70	100	4
		M203T : Topology-II	4	3	30	70	100	4
		M204T : Partial Differential Equations	4	3	30	70	100	4
		M205T: Numerical Analysis - I	4	3	30	70	100	4
	Practicals	**M206P:** Scilab Practicals based on paper M205T	2	3	15	35	50	1
Soft Core	**Theory**	**M207SC:** Elementary Number Theory	3	3	30	70	100	3
Total of Credits for II Semester								**24**

III SEMESTER								
Subjects		Papers	Instruction hrs/week	Duration of Exam (hrs)	Marks			Credits
					IA	Exam	Total	
Core Subject	Theory	**M 301T:** Differential Geometry	4	3	30	70	100	4
		M 302T: Fluid Mechanics	4	3	30	70	100	4
		M 303T: Functional Analysis	4	3	30	70	100	4
		M 304T: Linear Algebra	4	3	30	70	100	4
		M 305T: Numerical Analysis-II	4	3	30	70	100	4
	Practicals	**M 306P:** Scilab Practicals based on paper M305T	2	3	15	35	50	1
Open Elective (Choose any One)	Elective 1	**M 307OE(A):** Elements of Calculus	4	3	30	70	100	4
	Elective 2	**M 307OE (B):** Mathematics for every one						
Total of Credits for III Semester								**25**

IV SEMESTER								
Subjects		Papers	Instruction hrs/week	Duration of Exam (hrs)	Marks			Credits
					IA	Exam	Total	
Core Subject and Electives	Theory	**M 401 T :** Measure and Integration	4	3	30	70	100	4
		M 402 T: Mathematical Methods	4	3	30	70	100	4
	Elective (Choose any 3)	**M 403 T (A) :** Riemannian Geometry	3x4	3x3	3x30	3x70	3x100	3x 4=12
		M 403 T (B) : Special Functions						
		403 T (C) : Theory of Numbers						
		403 T (D) : Entire and Meromorphic Functions						
		M 403 T (E): Magnetohydrodynamics						
		M 403T(F): Fluid Dynamics of Ocean and Atmosphere						
		M 403 T (G) : Computational Fluid Dynamics (CFD)						
		M 403 T (H) : Finite Element Method with Applications						
		M 403 T (I) : Graph Theory						
		M 403 T (J) : Design and Analysis of Algorithms						
	Practicals	**M 404 P :** Latex and Latex Beamer	2	3	15	35	50	1
Project Work			8	**Report Evaluation**	30 (Viva)	70	100	4
Total of Credits for IV Semester								**25**
Program Grand Total of Credits								**98**

In the first two semesters there are 4 core papers, one practical paper and 1 soft core paper. In the third semester, the courses '**M 307OE (A)**' and '**M 307OE (B)**' are "Open Elective Courses" which are offered only to students of other departments. In the fourth semester, the core subjects'M401T' and 'M402T' are compulsory and a student can choose any three core papers from M403T (A - J). A project work is compulsory for every student. This involves self study to be carried out by the student on a research problem of current interest or on an advanced topic not covered in the syllabus under the guidance of a faculty member. The project report (dissertation) shall be submitted at the end of the fourth semester.

SCHEME OF EVALUATION:

Question Paper Pattern: Question paper pattern for all the theory papers (hard core and soft core including elective papers in IV semester) will be as follows:

Question paper will consist of **e**ight questions and will be distributed over the whole syllabus. The candidate is required to attempt any five questions.

Question paper pattern for open elective paper is as per the regulations set by the Bangalore University.

Break-up of practical marks (of 35 marks)

Practical Record	: 5 marks
Actual practicals	: 24 marks (2 Programs)
Viva	: 06 marks

B**reak-up of project work marks (of 100 marks)**

Project Report (Dissertation) Evaluation by two Examiners (one internal and one external)

: 70 Marks

Project Presentation and Viva-Voce (evaluation by two Examiners one internal and one external)

: 30 marks

INTERNAL ASSESSMENT MARKS

Internal assessment marks for theory (of 30 marks)

Internal two tests and assignments :**30 marks**

Internal assessment marks for practicals(of 15 marks)

Preparatory practical exam or two internal tests :**15 marks**

SYLLABI OF EACH SEMESTER

FIRST SEMESTER

M101T	Algebra-I	4 hours/week (52 Hours)	4 Credits

Group Theory (Recapitulation): Groups, Subgroups, Cyclic groups, Normal Subgroups, Quotient groups, Homomorphism, Types of homomorphisms. 2 Hrs.

Unit-1: Permutation groups, symmetric groups, cycles and alternating groups, dihedral groups, Isomorphism theorems and its related problems, Automorphisms, Inner automorphisms, groups of automorphisms and inner automorphisms and their relation with centre of a group. 6 Hrs.

Unit-2: Group action on a set, Orbits and Stabilizers, The orbit-stabilizer theorem, The Cauchy-Frobenius lemma, Conjugacy, Normalizers and Centralizers, Class equation of a finite group and its applications. 6 Hrs.

Unit-3: Sylow's groups and subgroups, Sylow's theorems for a finite group, Applications and examples of p-Sylow subgroups. 6 Hrs.

Unit-4: Solvable groups, Simple groups, Applications and examples of solvable and simple groups, Jordan - Holder Theorem. 6 Hrs.

Ring Theory (Recapitulation): Rings, Some special classes of rings (Integral domain, division ring, field). 2 Hrs.

Unit-5: Homomorphisms of rings, Kernel and image of Homomorphisms of rings, Isomorphism of rings, Ideals and Quotient rings, Fundamental theorem of homomorphism of rings, 6 Hrs.

Unit-6: Theorems on principle, maximal and prime ideals, Field of quotients of an integral domain, Imbedding of rings 6 Hrs.

Unit-7: Euclidean rings, Prime and relatively prime elements of a Euclidean ring, Unique factorization theorem, Fermat's theorem, Polynomial rings, The division algorithm. 6 Hrs.

Unit-8: Polynomials over the rational field, Primitive polynomial, Content of a polynomial. Gauss lemma, Eisenstein criteria, Polynomial rings over commutative rings, Unique Factorization Domains. 6 Hrs.

TEXT BOOKS

1. Herstein I.N. Topics in Algebra, 2nd Edition, Wiley India, 2016.
2. Surjeet Singh and Qazi Zameeruddin, Modern Algebra, 8th edition, Vikas Publishing House, 2006.
3. N. Jacobson, Basic Algebra-I, 2nd Revised edition edition, Dover Publications, 2009.

REFERENCE BOOKS

1. M. Artin : Algebra, Second Edition, Prentice Hall of India, 2011.
2. Darek F. Holt, Bettina Eick and Eamonaa. Obrien. Handbook of computational group theory, Chapman & Hall/CRC Press, 2005
3. J. B. Fraleigh : A first course in abstract algebra, 7^{th}ed., Addison-Wesley Longman, 2002.

M102T	Real Analysis	4 hours/week (52 Hours)	4 Credits

Unit-1: 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. 14 Hrs.

Unit-2: 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. 14 Hrs

Unit-3: 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 R^n, k-cell and its compactness, Heine-Borel Theorem, Bolzano Weirstrass theorem, Continuity, Compactness and uniform continuity. 11 Hrs.

Unit-4: Functions of several variables, continuity and Differentiation of vector-valued functions, Linear transformation of $\mathbf{R}^k$, properties and invertibility, Directional Derivative, Chain rule, Partial derivative, Hessian matrix. The Inverse Functions Theorem and its illustrations with examples. The Implicit Function Theorem and illustration and examples. The Rank theorem illustration and examples. 13 Hrs.

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.

M103T	Topology-I	4 hours/week (52 Hours)	4 Credits

Unit-1: Finite and Infinite sets. Denumerable and Non denumerable sets, Countable and Uncountable sets. Equivalent sets. Concept of Cardinal numbers, Schroeder- Bernstein Theorem. Cardinal number of a power set–Addition of Cardinal numbers, Exponential of Cardinal numbers, Examples of Cardinal Arithmetic, Cantor's Theorem. Card X < Card P(X). Relations connecting $\aleph_0$ and c. Continuum Hypothesis. Zorn's lemma (statement only). 14Hrs.

Unit-2: Definition of a metric. Bolzano - Weierstrass theorem. 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. 12 Hrs.

Unit-3: 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. 14 Hrs.

Unit-4: Connected spaces: Definition and examples, connected sets in the real line, Intermediate value theorem, components and path components, local connectedness and path connectedness. 12Hrs.

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. G J.L. Kelley, General Topology, Van Nostrand, Princeton, 1955.

M104T	Ordinary Differential Equations	4 hours/week (52 Hours)	4 Credits

Unit-1: Linear differential equations of nth order, fundamental sets of solutions, Wronskian - Abel's identity, theorems on linear dependence of solutions, adjoint - self - adjoint linear operator, Green's formula, Adjoint equations, the n^{th} order nonhomogeneous linear equations - Variation of parameters - zeros of solutions - comparison and separation theorems. 13 Hrs.

Unit-2: Fundamental existence and uniqueness theorem. Dependence of solutions on initial conditions, existence and uniqueness theorem for higher order and system of differential equations - Eigenvalue problems - Sturm-Liouville problems - Orthogonality of eigenfunctions - Eigenfunction expansion in a series of orthonormal functions- Green's function method. 13 Hrs.

Unit-3: Power series solution of linear differential equations - ordinary and singular points of differential equations, Classification into regular and irregular singular points; Series solution about an ordinary point and a regular singular point - Frobenius method- Hermite, Laguerre, Chebyshev and Gauss Hypergeometric equations and their general solutions. Generating function, Recurrence relations, Rodrigue's formula Orthogonality properties. Behaviour of solution at irregular singular points and the point at infinity. 13 Hrs.

Unit-4: Linear system of homogeneous and non-homogeneous equations (matrix method) Linear and Non-linear autonomous system of equations - Phase plane - Critical points - stability - Liapunov direct method - Limit cycle and periodic solutions-Bifurcation of plane autonomous systems. 13 Hrs.

TEXT BOOKS

1. G.F. Simmons: Differential Equations, TMH Edition, New Delhi, 1974.
2. M.S.P. Eastham: Theory of ordinary differential equations, Van Nostrand, London, 1970.
3. S.L. Ross: Differential equations (3^{rd} edition), John Wiley & Sons, New York, 1984.

REFERENCE BOOKS

1. E.D. Rainville and P.E. Bedient: Elementary Differential Equations, McGraw Hill, NewYork, 1969.
2. E.A. Coddington and N. Levinson: Theory of ordinary differential equations, McGraw Hill, 1955.
3. A.C. King, J. Billingham & S.R. Otto: Differential equations, Cambridge University Press, 2006.

M105T	Discrete Mathematics	4 hours/week (52 Hours)	4 Credits

Unit-1: Logic: Introduction to logic, Rules of Inference (for quantified statements), Validity of Arguments, Normal forms. Methods of proof: Direct, Indirect proofs, Proof by contradiction, Proof by cases etc., 5 Hrs.

Unit-2: Counting Techniques: The product rule, The sum rule, The inclusion–exclusion principle, The Pigeonhole Principle and examples. Simple arrangements and selections. Arrangements and selections with repetitions, Distributions, Binomial Coefficients. 7Hrs

Unit-3: Modeling with recurrence relations with examples of Fibonacci numbers and the tower of Hanoi problem, Solving recurrence relations. Divide-and-Conquer relations with examples (no theorems). Generating functions, definition with examples, solving recurrence relations using generating functions, exponential generating functions. Difference equations. 7 Hrs.

Unit-4: Definition and types of relations. Representing relations using matrices and digraphs, Closures of relations, Paths in digraphs, Transitive closures, Warshall's Algorithm. Order relations, Posets, Hasse diagrams, external elements, Lattices. 7 Hrs.

Unit-5: Introduction to graph theory, types of graphs, Basic terminology, Subgraphs, Representing graphs as incidence matrix and adjacency matrix. Graph isomorphism. Connectedness in simple graphs. Paths and cycles in graphs. Distance in graphs: Eccentricity, Radius, Diameter, Center, Periphery. Weighted graphs Dijkstra's algorithm to find the shortest distance paths in graphs and digraphs. 8 Hrs.

Unit-6: Euler and Hamiltonian Paths. Necessary and sufficient conditions for Euler circuits and paths in simple, undirected graphs. Hamiltonicity: noting the complexity of hamiltonicity, Traveling Salesman's Problem, Nearest neighbor method. 6 Hrs.

Unit-7: Planarity in graphs, Euler's Polyhedron formula. Kuratowski's theorem (statement only). Vertex connectivity, Edge connectivity, covering, Independence. 6 Hrs.

Unit-8: Trees, Rooted trees, Binary trees, Trees as models. Properties of trees. Minimum spanning trees. Minimum spanning trees. Prim's and Kruskul's Algorithms. 6 Hrs.

TEXT BOOKS

1. C. L. Liu: Elements of Discrete Mathematics, Tata McGraw-Hill, 2000.
2. Kenneth Rosen, WCB McGraw-Hill, 6th edition, 2004.

REFERENCE BOOKS

1. J.P. Tremblay and R.P. Manohar: Discrete Mathematical Structures with applications to computer science, McGraw Hill (1975).
2. F. Harary: Graph Theory, Addition Wesley, 1969.
3. J.H. Van Lint & R.M. Wilson, "A course on Combinatorics", Cambridge University Press (2006)
4. Allan Tucker, "Applied Combinatorics", John Wiley & Sons (1984).

M106P	**Maxima practicals based on paper M105T**	**2 hours/week**	**1 Credit**

1. Basics of Maxima - 4 hours.
2. Introducing "Graphs" package. Drawing graphs with different attributes.
3. Finding PCNF and PDNF.
4. Solving recurrence relations with boundary conditions.
5. Finding a generating function, given a sequence of coefficients.
6. Representing relations using digraphs and finding the nature of the given relation.
7. Warshall's algorithm to find transitive closure.
8. Hasse' diagram.
9. Lattice properties with extremal elements.
10. Graph Isomorphism.
11. Dijkstra's algorithm to find shortest distance paths and lengths.
12. Checking given graph to be Eulerian.
13. Nearest Neighbor method.
14. Determining minimum spanning tree using Prim's/ Kruskal's algorithm.

M107SC	Mathematical Analysis	3 hours/week (39 hours)	3 Credits

Unit-1: Recap of limits, continuity and differentiability of functions, Continuity and compactness, Continuity and connectedness. Infinite limits and limits at infinity. 8 Hrs

Unit-2: Mean value theorems, The continuity of derivatives, Derivatives of higher order, Taylor's theorems. 9 Hrs

Unit-3: Numerical sequences & series of real numbers, convergent sequences, Cauchy sequences, upper & lower limits, Some special sequences, Series, Series of non-negative terms, The number 'e'. 10 Hrs

Unit-4: Tests of convergence, Power series, Summation by parts, Absolute convergence, Addition and multiplication of series, Rearrangements. Double series, infinite products. 12 Hrs

TEXT BOOKS

1. W. Rudin: Principles of Mathematical Analysis, Intl. Student edition, McGraw Hill, 3rd Ed. 1986.
2. T. M. Apostol: Mathematical Analysis, New Delhi, Narosa, 2004.

REFERENCE BOOKS

1. S. Goldberg: Methods of Real Analysis, Oxford & IBH, 1970
2. Torence Tao - Analysis I, Hindustan Book Agency, India, 2006.
3. Torence Tao - Analysis II, Hindustan Book Agency, India, 2006.
4. Kenneth A. Ross - Elementary Analysis: The Theory of Calculus, Springer Intel. Edition, 2004.

SECOND SEMESTER

M201T	Algebra - II	4 hours/week (52 Hours)	4 Credits

Extended Ring Theory (Recapitulation) : Rings, Some special classes of rings (Integral domain, division ring, field, maximal and prime ideals). 2 Hrs.

Unit-1: Local ring, the Nil radical and Jacobson radical, operation on ideals, extension and contraction. The prime spectrum of a ring. 6 Hrs.

Unit-2: *Modules Theory:* Modules, submodules and quotient modules, module homomorphisms, Isomorphism theorems of modules. 6 Hrs.

Unit-3: Direct sums, Free modules, Finitely generated modules, Nakayama Lemma, Simple modules, Exact sequences of modules. 6 Hrs.

Unit-4: Modules with chain conditions - Artinian and Noetherian modules, modules of finite length, Artinian rings, Noetherian rings, Hilbert basis theorem. 6 Hrs.

Unit-5: *Field Theory:* Extension fields**,** Finite and algebraic extensions. degree of extension, algebraic elements and algebraic extensions, adjunction of an element of a field. 6 Hrs.

Unit-6: Roots of a polynomial, Splitting fields, Construction with straight edge and compass. 6 Hrs.

Unit-7: More about roots (Characteristic of a field), Simple and separable extensions, Finite field. 6 Hrs.

Unit-8: *Galois Theory:* Elements of Galois Theory, Fixed fields, Normal extension, Galois groups over the rationals, degree, distance. 8 Hrs.

TEXT BOOKS

1. M. F. Atiyah and I. G. Macdonald: Introduction to Commutative Algebra, Addison - Wesley. (Part A)
2. I.N. Herstein: Topics in Algebra, 2nd Edition, Vikas Publishing House, 1976. (Part B)

REFERENCE BOOKS

1. C. Musili: Introduction to Rings and Modules, Narosa Publishing House, 1997.
2. Miles Reid: Under-graduate Commutative Algebra, Cambridge University Press, 1996.
3. M. Artin: Algebra, Prentice Hall of India, 1991.
4. N. Jacobson: Basic Algebra-I, HPC, 1984.
5. J. B. Fraleigh: A first courses in Algebra, 3rd edition, Narosa 1996.

M202T	Complex Analysis	4 hours/week (52 Hours)	4 Credits

Unit-1: Analytic functions, Harmonic conjugates, Elementary functions, Cauchy's Theorem and Integral formula, Morera's Theorem, Cauchy's Theorem for triangle, rectangle, Cauchy's Theorem in a disk, Zeros of Analytic function. The index of a closed curve, counting of zeros. Principle of analytic Continuation. Liouville's Theorem, Fundamental theorem of algebra. 12 Hrs.

Unit-2: Series, Uniform convergence, Power series, Radius of convergences, Power series representation of Analytic function, Relation between Power series and Analytic function, Taylor's series, Laurent's series. 9 Hrs.

Rational Functions, Singularities, Poles, Classification of Singularities, Characterization of removable Singularities, poles. Behaviour of an Analytic function at an essential singular point. 5 Hrs

Unit-3: Entire and Meromorphic functions. The Residue Theorem, Evaluation of Definite integrals, Argument principle, Rouche's Theorem, Schwartz lemma, Open mapping and Maximum modulus theorem and applications, Convex functions, Hadmard's Three circle theorem. 14 Hrs.

Unit-4: Phragmen-Lindelof theorem, The Riemann mapping theorem, Weistrass factorization theorem. Harmonic functions, Mean Value theorem. Poisson's formula, Poisson's Integral formula, Jensen's formula, Poisson's - Jensen's formula. 12 Hrs.

TEXT BOOKS

1. J. B. Conway: Functions of one complex variable, Narosa, 1987.
2. L.V. Ahlfors: Complex Analysis, McGraw Hill, 1986.

REFERENCE BOOKS

1. R. Nevanlinna: Analytic functions, Springer, 1970.
2. E. Hille: Analytic Theory, Vol. I, Ginn, 1959.
3. S. Ponnuswamy: Functions of Complex variable, Narosa Publications

M203T	Topology-II	4 hours/week (52 hours)	4 Credits

Unit-1: 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. 7 Hrs.

The axioms of countability: First axiom space, Second countable space, Separability and the Lindelof property and their equivalence for metric spaces. 6 Hrs.

Unit-2: The product topology, the metric topology, the quotient topology, Product invariant properties for finite products, Projection maps. 6 Hrs.

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. 7 Hrs.

Unit-3: 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. 6 Hrs.

Complete regularity, Normality and the T_4 - axiom, Metric space is T_4, compact Hausdorff space and regular lindelof spaces are normal. 7 Hrs.

Unit-4: Urysohn's Lemma, Tietze's Extension Theorem, Complete normality and the T_5 -axiom. 7 Hrs.

Local finiteness, Paracompactness, Normality of a paracompact space, Metrizability, Urysohn metrization theorem, 6 Hrs.

TEXT BOOKS

1. J.R. Munkres: Topology, 2nd Ed., Prentice Hall of India (India), 2007.
2. W.J. Pervin: Foundations of General Topology - Academic Press, 1964.

REFERENCE BOOKS

1. G.F. Simmons: Introduction to Topology & Modern Analysis (McGraw-Hill Interl Edn), 1963
2. G J.L. Kelley, General Topology, Van Nostrand, Princeton, 1955.
3. J. Dugundji : Topology - Prentice Hall of India, 1975.

M204T	Partial Differential Equations	4 hours/week (52 hours)	4 Credits

Unit-1: First Order Partial Differential Equations: Basic definitions, Origin of PDEs, Classification, Geometrical interpretation. The Cauchy problem, the method of characteristics for Semi linear, quasi linear and Non-linear equations, complete integrals, Examples of equations to analytical dynamics, discontinuous solution and shockwaves. 12 Hrs.

Unit-2: Second Order Partial Differential Equations: Definitions of Linear and Non-Linear equations, Linear Superposition principle, Classification of second-order linear partial differential equations into hyperbolic, parabolic and elliptic PDEs, Reduction to canonical forms, solution of linear Homogeneous and non-homogeneous with constant coefficients, Variable coefficients, Monge's method. 14 Hrs.

Unit-3: Wave equation: Solution by the method of separation of variables and integral transforms The Cauchy problem, Wave equation in cylindrical and spherical polar coordinates. 6 Hrs.

Laplace equation: Solution by the method of separation of variables and transforms. Dirichlet's, Neumann's and Churchills problems, Dirichlet's problem for a rectangle, half plane and circle, Solution of Laplace equation in cylindrical and spherical polar coordinates 7 Hrs.

Unit-4: Diffusion equation: Fundamental solution by the method of variables and integral transforms, Duhamel's principle, Solution of the equation in cylindrical and spherical polar coordinates. 7 Hrs.

Solution of boundary value problems: Green's function method for Hyperbolic, Parabolic and Elliptic equations. 6 Hrs.

TEXT BOOKS

1. I. N. Sneddon, Elements of PDE's, McGraw Hill Book company Inc., 2006.
2. L Debnath, Nonlinear PDE's for Scientists and Engineers, Birkhauser, Boston, 2007.
3. F. John, Partial differential equations, Springer, 1971.

REFERENCE BOOKS

1. F. Treves: Basic linear partial differential equations, Academic Press, 1975.
2. M.G. Smith: Introduction to the theory of partial differential equations, Van Nostrand, 1967.
3. Shankar Rao: Partial Differential Equations, PHI, 2006.

M205T	Numerical Analysis - I	4 hours/week (52 hours)	4 Credits

Examples from algebraic and transcendental equations where analytical methods fail. Examples from system of linear and non-linear algebraic equations where analytical solutions are difficult or impossible. Floating-point number and round-off, absolute and relative errors. 4 Hrs.

Unit-1: Solution of nonlinear equation in one variable

Fixed point iterative method - convergence and acceleration by Aitken's Δ^2-process. Newton-Raphson methods formultiple roots and their convergence criteria, Ramanujan method, Bairstow's method, Sturm sequence for identifying the number of real roots of the polynomial functions, complex roots-Muller's method. Homotopy and continuation methods. 10 Hrs.

Unit-2: Solving system of equations

Review of matrix algebra. Gauss-elimination with pivotal strategy. Factorization methods (Crout's, Doolittle and Cholesky). Tri-diagonal systems-Thomas algorithm. Iterative methods: Matrix norms, error analysis and ill-conditioned systems- Jacobi and Gauss-Seidel methods, Chebyshev acceleration. Introduction to steepest descent and conjugate gradient methods. Solutions of nonlinear equations: Newton-Raphson method, Quasilinearization (quasi-Newton's) method, successive over relaxation method. 14 Hrs.

Unit-3: Interpolation

Review of interpolations basics, Lagrange, Hermite methods and error analyses, Splines-linear, quadratic and cubic (natural, Not a knot and clamped), Bivariate interpolation, Least-squares, Chebyshev and rational approximations. 14 Hrs.

Unit-4: Numerical integration

Review of integrations. Gaussian quadrature - Gauss-Legendre, Gauss-Chebyshev, Gauss-Lagaurre, Gauss-Hermite and error analyses, adaptive quadratures, multiple integration with constant and variable limits. 10Hrs

TEXT BOOKS

1. S.D. Cante & C de Boor: Elementary numerical analysis, Tata-Mc Graw-Hill,1980 3 edition.
2. R.L. Burden and J.D. Faires: Numerical Analysis, Thomson-Brooks/Cole, 1989, 7 edition.
3. D. Kincade and W Cheney: Numerical analysis, American Mathematical Society, 2002, 3 edition.

REFERENCE BOOKS

1. A Iserles: A first course in the numerical analysis of differential equations, Cambridge texts in applied mathematics, 2008, 2 edition

M206P	Scilab Practicals based on M205T	2 hours/week	1 Credit

List of programs :

Introduction to Scilab - 2 weeks

Programs for finding the root of the function using

1. Fixed-point iterative method
2. Newton-Raphson method
3. Newton-Raphson method for multiple roots
4. Ramanujan method
5. Mullers method

Programs for the solution of system of equations using

6. Gauss-elimination method with pivoting
7. Crout's LU Decomposition method
8. Doolittle LU Decomposition method
9. Thomas Algorithm
10. Gauss-Seidel iterative method
11. Jacobi iterative method
12. Conjugate gradient method

Programs on interpolation using

13. Lagrange interpolation method
14. Cubic Spline interpolation method
15. Rational function approximation

Program on numerical integration using

16. Gauss-Legendre method
17. Gauss-Chebyshev method
18. Gauss-Hermite method
19. Double integrals

M207SC	**Elementary Number Theory**	**3 hours/week (39 hours)**	**3 Credits**

Unit-1: Divisibility and Primes: Recapitulation of Division algorithm, Euclid's algorithm, Least Common Multiples, Linear Diophantine equations. Prime numbers and Prime-power factorisations, Distribution of primes, Fermat and Mersenne primes, Primality testing and factorization. 9Hrs

Unit-2: Congruences : Recapitulation of basic properties of congruences, Residue classes and complete residue systems, Linear congruences. Reduced residue systems and the Euler-Fermat theorem, Polynomial congruences modulo p and Langrange's theorem, Simultaneous linear congruences, Simultaneous non-linear congruences, An extension of Chinese Remainder Theorem, Solving congruences modulo prime powers. 11Hrs

Unit-3: Quadratic Residues and Quadratic Reciprocity Law : Quadratic residues, Legendre's symbol and its properties, Euler's criterion, Gauss lemma, The quadratic reciprocity law and its applications, The Jacobi symbol, Applications to Diophantine equations. 11Hrs

Unit-4: Sums of squares, Fermat's last theorem and Continued fractions: Sums of two squares, Sums of four squares, The Pythagoras theorem, Pythagorean triples and their classification, Fermat's Last Theorem (Case $n = 4$). 8Hrs

TEXT BOOKS

1. G. A. Jones and J. M. Jones, Elementary Number Theory, Springer UTM, 2007.
2. Tom M. Apostol - Introduction to Analytic Number Theory, Springer, 1989.
3. D. Burton; Elementary Number Theory, McGraw-Hill, 2005.

REFERENCES

1. Niven, H.S. Zuckerman & H.L. Montgomery, Introduction to the Theory of Numbers, Wiley, 2000.
2. H. Davenport, The Higher Arithmetic, Cambridge University Press, 2008.

THIRD SEMESTER

M301T	Differential Geometry	4 hours/week (52 hours)	4 Credits

Unit-1: Calculus on Euclidean Space: Euclidean space. Natural coordinate functions. Differentiable functions. Tangent vectors and tangent spaces. Vector fields. 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.13 Hrs.

Unit-2: 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. Cylindrical helix Covariant derivatives and covariant differentials. Cylindrical and spherical frame fields. Connection forms. Attitude matrix. Structural equations. Isometries of E^3 - Translation, Rotation and Orthogonal transformation. The derivative map of an isometry. 13 Hrs.

Unit-3: 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 a function 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. 13 Hrs.

Unit-4: Shape Operators: Definition of shape operator. 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. Special surface - Surface of revolution. 13 Hrs.

TEXT BOOKS

1. Barrett O' Neil : Elementary Differential Geometry. Academic Press, New York and 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, Massachusetts, 1961.
2. Nirmala Prakassh: Differential Geometry - an integrated approach. Tata McGraw-Hill, New Delhi, 1981.

M302T	Fluid Mechanics	4 hours/week (52 hours)	4 Credits

Unit-1: Coordinate transformations: Cartesian tensors - Basic Properties – Transpose - Symmetric and Skew tensors - Isotropic tensors - Deviatoric Tensors - Gradient, Divergence and Curl of a tensor field- Integral Theorems. 7Hrs.

Continuum Hypothesis: Configuration of a continuum - Mass and density - Description of motion - Material and spatial coordinates - Material and Local time derivatives- Stream lines - Path lines - Vorticity and Circulation - Examples. Transport formulas - Strain tensors - Principal strains, Strain-rate tensor- Stress components and Stress tensor - Normal and shear stresses - Principal stresses. 7Hrs.

Unit-2: Fundamental basic physical laws: Law of conservation of mass - Principles of linear and angular momenta - Balance of energy - Examples. 6Hrs.

Motion of non-viscous fluids: Stress tensor- Euler equation-Bernoulli's equation- simple consequences-Helmholtz vorticity equation - Permanence of vorticity and circulation - Dimensional analysis - Nondimensional numbers. 6Hrs.

Unit-3: Motion of Viscous fluids: Stress tensor - Navier-Stokes equation - Energy equation -Simple exact solutions of Navier-Stokes equation: (i) Plane Poiseuille and Hagen-Poiseuille flows (ii) Generalized plane Couette flow (iii) Steady flow between two rotating concentric circular cylinders (iv) Stokes's first and second problems. Diffusion of vorticity - Energy dissipation due to viscosity. 13Hrs.

Unit-4: Two dimensional flows of inviscid fluids: Meaning of two-dimensional flow -Stream function - Complex potential - Line sources and sinks - Line doublets and vortices - Images - Milne-Thomson circle theorem and applications - Blasius theoremand applications. 13Hrs

TEXT BOOKS

1. D.S. Chandrasekharaiah and L. Debnath: Continuum Mechanics, Academic Press, 1994.
2. A.J.M. Spencer: Continuum Mechanics, Longman, 1980.
3. S. W. Yuan: Foundations of Fluid Mechanics, Prentice Hall, 1976.

REFERENCE BOOKS

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. Y.C. Fung, A First course in Continuum Mechanics, Prentice Hall (2nd edition), 1977.
4. Pijush K. Kundu, Ira M. Cohen and David R. Dowling, Fluid Mechanics, Fifth Edition, 2010.
5. C.S. Yih : Fluid Mechanics, McGraw-Hill, 1969.

M303T	Functional Analysis	4 hours/week (52 hours)	4 Credits

Unit-1: Normed linear spaces. Banach Spaces : Definition and examples. Quotient Spaces. Convexity of the closed unit sphere of a Banach Space. Examples of normed linear spaces which are not Banach. Holder's inequality. Minkowski's inequality. Linear transformations on a normed linear space and characterization of continuity of such transformations. 10 Hrs.

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**. Reflexive spaces. 4 Hrs.

Unit-2: Hahn - Banach theorem and its consequences, Projections on a Banach Space. The open mapping theorem and the closed graph theorem. The uniform boundedness theorem. The conjugate of an operator, properties of conjugate operator. 12 Hrs.

Unit-3: Inner product spaces, 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. 7 Hrs.

Orthogonal sets in a Hilbert space. Bessel's inequality. orthogonal complements, complete orthonormal sets, Orthogonal decomposition of a Hilbert space. Characterization of complete orthonormal set. Gram-Schmidt orthogonalization process. 6 Hrs.

Unit-4: 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* on B (H). Self-adjoint operators, Positive operators. Normal operators. Unitary operators and their properties. 7 Hrs.

Projections on a Hilbert space. Invariant subspace. Orthogonality of projections. Eigen values and eigen space of an operator on a Hilbert Space. Spectrum of an operator on a finite dimensional Hilbert Space. Finite dimensional spectral theorem. 6 Hrs.

TEXT BOOKS

1. G.F. Simmons: Introduction to Topology & Modern Analysis (McGraw-Hill Intl. Edition), 1998.
2. G. Backman and L. Narici: Functional Analysis (Academic), 2006.

REFERENCE BOOKS

1. B. V. Limaye: Functional Analysis (Wiley Eastern), 1998.
2. P. R. Halmos: Finite dimensional vector paces, Van Nostrand, 1958.
3. E. Kreyszig: Introduction to Functional Analysis with Applications, John Wiley & Sons, 2000.

M304T	Linear Algebra	4 hours/week (52 hours)	4 Credits

Recapitulation: Vector Spaces, Subspaces, Linear Combinations and Systems of Linear Equations, Linear dependence and independence, Basis and Dimension, Maximal linearly independence subsets, Direct sums, Linear transformation, Linear Operators. 4 Hrs.

Unit-1: Algebra of Linear transformations, Minimal polynomials, Regular and singular transformation, Range and rank of a transformation and its properties, characteristic roots and characteristic vectors. 8 Hrs.

Unit-2: The matrix representation of a linear transformation, Composition of a linear transformation and matrix multiplication, The change of coordinate matrix, transition matrix, The dual space. 6 Hrs.

Unit-3: Characteristic polynomials, Diagonalizability, Invariant subspaces, Cayley-Hamilton theorem. 6 Hrs.

Unit-4: Canonical Forms: Triangular canonical form, Nilpotent transformations, Jordan canonical form, The rational canonical form. 8 Hrs.

Unit-5: Inner Product Spaces, Orthogonal complements, Gram-Schmidt orthonormalization process. 6 Hrs.

Unit-6: Positive Definite Matrices, Maxima, minima and saddle points, Tests for positive definiteness, Singular value Decomposition and its applications. 6 Hrs.

Unit-7: Bilinear forms, symmetric and skew-symmetric bilinear forms, real quadratic forms, rank and signature, Sylvester's law of inertia. 6 Hrs.

TEXT BOOKS

1. K. Hoffman and R. Kunze, Linear Algebra, Pearson Education (India), 2003. Prentice-Hall of India, 1991.
2. I. N. Herstein, Topics in Algebra, 2nd Ed., John Wiley & Sons, 2006
3. S. Freidberg. A Insel, and L Spence: Linear Algebra, Fourth Edition, PHI, 2009.
4. J. Gilbert and L. Gilbert, Linear Algebra and Matrix theory, Academic Press, 1995.

REFERENCE BOOKS

1. S. Lang, Linear Algebra, Springer-Verlag, New York, 1989.
2. M. Artin, Algebra, Prentice Hall of India, 1994.
3. G. Strang: Linear Algebra and its Applications, Brooks/Cole Ltd., New Delhi, Third Edition, 2003.
4. L. Hogben-Handbook of Linear Algebra-Chapman and Hall-CRC (2006).

M305T	Numerical Analysis - II	4 hours/week (52 hours)	4 Credits

Unit-1: Examples from ODE where analytical solution are difficult or impossible. Examples from PDE where analytical solution are difficult or impossible. 4 Hrs

Numerical solution of ordinary differential equations: Initial value problems**:** Picard's and Taylor series methods. Euler's and Modified Euler's methods, Runge-Kutta methods of second and fourth order, Runge-Kutta-Fehlberg methods. 10 Hrs

Multistep methods - the Adams-Bashforth and Adams-Moulton predictor-corrector methods. Local and global errors, stability analyses for the above methods. Methods for systems and higher order differential equations. Boundary value problems**:** Shooting methods and cubic spline methods. 12 Hrs

Unit-2: Numerical solution of partial differential equations: Elliptic equations: Difference schemes for Laplace and Poisson's equations. Parabolic equations: Difference methods for one-dimension– methods of Schmidt, Laasonen, Dufort-Frankel and Crank-Nicolson. Alternating direction implicit method for two-dimensional equation. 13 Hrs

Hyperbolic equations**:** Difference methods for one-dimension- explicit and implicit schemes, D'Yakonov split and Lees alternating direction implicit methods for two-dimensional equations.

Stability and convergence analyses for the above equations. 13 Hrs.

TEXT BOOKS

1. MK Jain: Numerical solution of differential equations, Wiley Eastern, 1979, 2 Edition.
2. RL Burden and JD Faires: Numerical Analysis, Thomson-Brooks/Cole, 1989, 7edition.
3. S Larsson and V Thomee: Partial differential equations with numerical methods, Springer, 2008, 1 edition.
4. JW Thomas : Numerical partial differential equations: finite difference methods, Springer, 1998, 2 Edition.

REFERENCE BOOKS

1. D Kincade and W Cheney: Numerical analysis, American Mathematical Society, 2002, 3 edn.
2. AIserles: A first course in the numerical analysis of differential equations, Cambridge texts in applied mathematics, 2008, 2 edition.

M 306P	Scilab Practicals based on M305T	2 hours/week	1 Credit

Programs for solution of ordinary differential equations using

1. Euler's method and Modified Euler's method
2. Runge-Kutta 2 and 4 order methods
3. Runge-Kutta-Fehlberg order method
4. Runge-Kutta for system of equations
5. Adam's Predictor-corrector method
6. Finite difference methods
7. Shooting methods

Programs for solution of partial differential equations using

8. Laplace equation
9. Poisson equation
10. Schmidt Method
11. Crank-Nicolson method
12. ADI method
13. Explicit method for wave equation
14. Lees ADI method for wave equation

M 307OE (A)	Elements of Calculus	4 hours/week (52 hours)	4 Credits

Unit-1: Differential Calculus: Limit and continuity, properties of limits and classification of discontinuities. Derivatives, Rules for Differentiation, higher order derivatives, chain rule, implicit differentiation. Successive differentiation and Leibnitz Theorem. 14 Hrs

Unit-2: Statement of Rolle's Theorem, Mean Value Theorem, Taylor and Maclaurin's theorems. Integral Calculus: Integration. Methods of Integration: substitution method, partial fractions, integration by parts, definite integrals, indefinite integrals. 14 Hrs.

Unit-3: Applications of differentiation and integration: Increasing and decreasing functions. Relative Extrema maxima and minima, convexity, curve sketching. 12 Hrs.

Unit-4: Asymptotes, concavity, convexity and points of inflection. Determine the average value of a function, area between two curves, volume of a solid figure, simple examples. 12 Hrs.

TEXT BOOKS

1. L. Bers and F. Karal, Calculus, IBH Publishing, Bombay, 1976
2. S. Misra, Fundamentals of Mathematics-Differential Calculus, First Edition, Pearson, India, 2013.
3. S. Misra, Fundamentals of Mathematics-Integral Calculus, First Edition, Pearson, India, 2013.

REFERENCE BOOKS

1. Courant, R. and F. John, Introduction to Calculus and Analysis, Volume I, 1999
2. Courant, R. and F. John, Introduction to Calculus and Analysis, Volume II, 2000

M 307OE (B)	**Mathematics for Everyone**	**4 Hrs/week (52 hours)**	**4 Credits**

Unit-1: Basic Concepts in Mathematics: The number systems: Natural numbers, Integers, Rational and Irrational numbers, Real numbers, Complex numbers, Prime numbers. The concept of Sets: Subsets and equality of sets, set operations (union, intersection, and difference). Equivalence relations and types of functions (one-one, onto, many-one functions with examples) Mathematical logic, methods of proof, Mathematical inductions. 13 Hrs

Unit-2: Elements of Higher Arithmetic Divisibility: Divisibility, some theorems on divisibility, Primes, The Binomial theorem. Congruences: Congruences, Solution of congruences, The Chinese Remainder theorem. 13 hrs

Unit-3: Fundamentals of Groups: Theory Groups, subgroups, cyclic groups, normal subgroups. quotient groups, homomorphisms, natural homeomorphisms. kernel and image of a homomorphism and their properties. Isomorphism and fundamental theorem of homomorphism of groups.13 Hrs

Unit-4: Elements of calculus: Functions of one variable, Limits, continuity and differentiations of functions of a single variable. Derivatives of composite functions, parametric functions, logarithmic functions, exponential and inverse functions. 13 Hrs

TEXT BOOKS:

1. Introduction to the theory of numbers, Ivan Niven, Herbert S. Zuckerman, Hugh L. Montgomery, 5th Edition, John Wiley. 1991.
2. Contemporary abstract algebra, Joseph A. Gallian, Houghton Miflin Company, 2001
3. Calculus Volume – I, T. M. Apostol, Wiley India Ltd. 2007

REFERENCE BOOKS:

1. Introduction to Analytic Number theory, Tom M. Apostol, 1st edition, Springer, 2009
2. Thomas' Calculus, George B. Thomas Jr. Maurice D. Weir, Joel R. Hass, 13th Edition, Pearson. 2014
3. Abstract Algebra, David Dummit and Richard R. Foote, John Wiley & Sons.2007.

FOURTH SEMESTER

M401T	Measure and Integration	4 hours/week (52 hours)	4 Credits

Unit-1: Algebra of sets, sigma algebras, open subsets of real line, F_σ and G_δ sets, Borel sets. (Lebesgue) Outer measure of a subset of R, existence, non-negativity and monotonicity of Lebesgue outer measure, Relation between Lebesgue outer measure and length of an interval; Countable subadditivity of Lebesgue outer measure; translation invariance. (Lebesgue) measurable sets, (Lebesgue) measure, Complement, union, intersection and difference of measurable sets, denumerable union, and intersection of measurable sets; 14 Hrs.

Unit-2: Countable additivity of measure; The class of measurable sets as an algebra, sigma-algebra, the measure of the intersection of a decreasing and increasing sequence of measurable sets; measures of limit superior, limit inferior of sequences of measurable sets. Measurable functions: Scalar multiple, sum, difference, and product of measurable functions. 10 Hrs.

Unit-3: Measurability of a continuous function and measurability of a continuous image of measurable function. Convergence pointwise and convergence in measures of a sequence of measurable functions.

Lebesgue Integral: Characteristic function of a set, simple function, Lebesgue integral of a simple function, Lebesgue integral of a bounded measurable function, Lebesgue integral and Riemann integral of a bounded function defined on a closed interval; Lebesgue integral of a non-negative function; Lebesgue integral of a measurable function, Properties of Lebesgue integral. 14 Hrs.

Unit-4: Convergence theorems and Lebesgue integral; The bounded convergence theorem, Fatou's lemma, Monotone convergence theorem, Lebesgue convergence theorem. 6 Hrs.

Differentiation of monotone functions, Vitali covering lemma, Functions of bounded variation, Differentiability of an integral, Absolute continuity and indefinite integrals. 8 Hrs.

TEXT BOOKS

1. H.L. Royden : Real Analysis, Macmillan, 1963
2. P.K. Jain, V.P. Gupta, Pankaj Jain: Lebesgue Measure &Integration, New Age International, 2011.

REFERENCE BOOKS

1. P.R. Halmos : Measure Theory, East West Press, 1962
2. W. Rudin : Real & Complex Analysis, McGraw Hill, 1966.

M402T	Mathematical Methods	4 hours/week (52 hours)	4 Credits

Unit-1: Integral Transforms: General definition of integral transforms, Kernels, etc. Development of Fourier integral, Fourier transforms - inversion, Illustration on the use of integral transforms, Laplace, Fourier, Hankel transforms to solve ODEs and PDEs - typical examples. Discrete orthogonality and Discrete Fourier transform. Wavelets with examples, wavelet transforms. 12 Hrs.

Unit-2: 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. Hilbert Schmidt theorem, Raleigh Ritz and Galerkin methods. 14 Hrs

Unit-3: Asymptotic Expansions: Asymptotic expansion of functions, power series as asymptotic series, Asymptotic forms for large and small variables. Uniqueness properties and Operations.
Asymptotic expansions of integrals; Method of integration by parts (include examples where the method fails), Laplaces method and Watson's lemma, method of stationary phase and steepest descent. 12 Hrs

Unit-4: Perturbation methods: Regular and singular perturbation methods: Parameter and co-ordinate perturbations. Regular perturbation solution of first and second order differential equations involving constant and variable coefficients. Include Duffings equation, Vanderpol oscillator, small Reynolds number flow. Singular perturbation problems, Matched asymptotic expansions, simple examples. Linear equation with variable coefficients and nonlinear BVP's. Problems involving Boundary layers. Poincare - Lindstedt method for periodic solution. WKB method, turning points, zeroth order Bessel function for large arguments, solution about irregular singular points. 14 Hrs

TEXT BOOKS

1. IN Sneddon: The use of Integral Transforms, Tata Mc Graw Hill, Publishing Company Ltd, New Delhi, 1974.
2. RP Kanwal: Linear integral equations theory & techniques, Academic Press, NewYork, 1971.
3. CM Bender and SA Orszag: Advanced mathematical methods for scientists and engineers, Mc Graw Hill, New York, 1978.
4. HT Davis: Introduction to nonlinear differential and integral equations, Dover Publications, 1962.
5. AH Nayfeh: Perturbation Methods, John Wiley & Sons, New York, 1973.

REFERENCE BOOKS

1. D Hong, J Wang and R Gardner: Real analysis with introduction to wavelets and applications, Academic Press Elsevier (2006)
2. RV Churchill: Operational Mathematics, Mc. Graw Hill, New York, 1958.

M403T (A)	**Riemannian Geometry**	**4 hours/week (52 hours)**	**4 Credits**

Unit-1: Differentiable manifolds: Charts, Atlases, Differentiable structures, Topology induced by differentiable structures, equivalent atlases, complete atlases. Manifolds. Examples of manifolds. Properties of induced topology on manifolds. Tangent and cotangent spaces to a manifold. Vector fields. Lie bracket of vector fields. 14 Hrs.

Unit-2: Smooth maps and diffeomorphism. Derivative (Jacobi) of smooth maps and their matrix representation. Pull back functions. Tensor fields and their components. Transformation formula for components of tensors. Operations on tensors. Contraction, Covariant derivatives of tensor fields. 14 Hrs.

Unit-3: Riemannian Metric. Connections. Riemannian connections and their components, Parallel translation, Fundamental theorem of Riemannian Geometry. Curvature and torsion tensors. Bianchi identities, Curvature tensor of second kind. Sectional curvature. Space of constant curvature. Schur's theorem. 14 Hrs.

Unit-4: Curves and geodesics in Riemannian manifold. Geodesic curvature, Frenet formula. Hypersurfaces of Riemannian manifolds Gauss formula, Gauss equation, Codazzi equation, Sectional curvature for a hyper surface of a Riemannian manifold, Gauss map, Weingartan map and Fundamental forms on hypersurface. Equations of Gauss and Codazzi. Gauss theorem egregium. 10 Hrs.

TEXT BOOKS

1. Y. Matsushima : Differentiable manifolds. Marcel Dekker Inc. New, York, 1972.
2. W.M .Boothby : An introduction to differentiable manifolds and Riemannian Geometry. Academic Press Inc. New York, 1975.
3. N.J. Hicks : Notes on differential Geometry D. Van Nostrand company Inc. Princeton, New Jersey, New York, London (Affiliated East-West Press Pvt. Ltd. New Delhi), 1998.
4. K.S. Amur, D.J. Shetty and C.S. Bagewadi, An Introduction to Differential Geometry, Narosa Pub. New Dehli, 2010.

REFERENCE BOOKS

1. R.L. Bishop and Grittendo : Geometry of manifolds. Acamedic Press, New York, 1964.
2. L.P. Eisenhart: Riemannian Geometry. Princeton University Press, Princetion, New Jersey, 1949.
3. H. Flanders: Differential forms with applications to the physical science, Academic Press, New York, 1963.
4. R.L. Bishop and S.J. Goldberg : Tensor analysis on manifolds, Macmillan Co., 1968.

M403T (B)	Special Functions	4 hours/week (52 hours)	4 Credits

Unit-1: Hypergeometric series: Definition – convergence - Solution of second order ordinary differential equation or Gauss equation - Confluent hypergeometric series - Binomial theorem, Integral Representation - Gauss's Summation formula - Chu-Vandermonde Summation formula-Pfaff-Kummer Transformation Formula - Euler's transformation formula. 12 Hrs.

Unit-2: Basic-hypergeometric series: Definition- Convergence- q– binomial theorem- Heines transformation formula and its q-analogue- Jackson transformation formula- Jacobi's triple product identity and its applications (proof as in ref. 9)- Quintuple product identity (proof as in reference 10) - Ramanujan's 1 ψ1 summation formula and its applications- A new identity for$(q;q)_\infty^{10}$with an application to Ramanujan partition congruence modulo 11- Ramanujan theta-function identities involving Lambert series. 14 Hrs.

Unit-3: q–series and Theta-functions: Ramanujan's general theta-function and special cases- Entries 18, 21, 23, 24, 25, 27, 29, 30 and 31 of Ramanujan's Second note book (as in text book reference 4).

Unit-4: Partitions: Definition of partition of a +ve integer- Graphical representation- Conjugate- Self-conjugate- Generating function of p (n)- other generating functions- A theorem of Jacobi- Theorems 353 and 354- applications of theorem 353- Congruence properties of p (n)- p (5n + 4) ≡ 0 (mod 5) and p (7n + 4) ≡ 0 (mod 7). 14 Hrs

Unit-5: Two theorems of Euler- Rogers-Ramanujan Identities- combinatorial proofs of Euler's identity, Euler's pentagonal number theorem. Franklin combinatorial proof. Restricted partitions - Gaussian. (portion to be covered as per Chapter-XIX of 'An Introduction to the Theory of Numbers' written by G. H. Hardy and E. M. Wright). 12 Hrs.

TEXT BOOKS

1. C. Adiga, B. C. Berndt, S. Bhargava and G. N. Watson, Chapter 16 of Ramanujan's second notebook: Theta-function and q-series, Mem. Amer. Math. Soc., 53, No. 315, Amer. Math. Soc., Providence, 1985.
2. T. M. Apostol: Introduction to Analytical number theory, Oxford University Press, 2000.
3. G. E. Andrews, The theory of Partition, Cambridge University Press, 1984
4. B. C. Berndt, Ramanujans notebooks, Part-III, Springer-Verlag, New York, 1991.
5. B. C. Berndt, Ramanujan's notebooks, Part-IV, Springer-Verlag, New York, 1994
6. B. C. Berndt, Ramanujans notebooks, Part-V, Springer-Verlag, New York, 1998
7. George Gasper and Mizan Rahman, Basic hyper-geometric series, Cambridge University Press, 1990.

8. G. H. Hardy and E. M. Wright, An Introduction of the Theory of Numbers, Oxford University Press, 1996.

REFERENCE BOOKS

1. B.C. Berndt, S. H. Chan, Zhi-Guo Liu and Hamza Yesilyurt, A new identities for$(q;q)_\infty^{10}$ with an application to Ramanujan partition congruence modulo 11, Quart. J. Math. 55, 13-30, 2004.
2. M.S. Mahadeva Naika and H.S. Madhusudhan, Ramanujan's Theta-function identities involving Lambert Series, Adv. Stud. Contemp. Math., 8, No. 1, 3-12, MR 2022031 (2004j: 33021), 2004.
3. M. S. Mahadeva Naika and K. Shivashankara, Ramanujan's${}_1\Psi_1$ summation formula and related identities, Leonhard Paul Euler Tricentennial Birthday Anniversary Collection, J. App. Math. Stat., 11(7), pp. 130-137, 2007.
4. Sarachai Kongsiriwong and Zhi-Guo Liu, Uniform proofs of q-series-product identity, Result. Math., 44(4), pp. 312-339, 2003.
5. Shaun Cooper, The Quintuple product identity, International Journal of Number Theory, Vol. 2(1), 115-161, 2006.

M403T (C)	Theory of Numbers	4 hours/week (52 hours)	4 Credits

Unit-1: Multiplicative and completely multiplicative functions. Euler Toteint function. Möbius and Mangoldt function. Dirichlet product and the group of arithmetical function. Generalised convolution. Formal power series. Bell series. 16 Hrs.

Unit-2: Residue Classes and complete Residue Classes, Linear Congruences and Euler-Fermat Theorem, General Polynomial congruences and Lagrange Theorem, Wilson's Theorem, Chinese Reminder Theorem. Fundamental Theorem on Polynomial Congruences with prime power moduli. Quadratic Residue and Gauss's Law of Quadratic Reciprocity. (both for Legendre and Jacobi symbols) Primitive roots and their existence for moduli m=1, 2, 4, p^α, $2p^\alpha$. 18 Hrs

Unit-3: Partition: partition of a +ve integer, Graphical representation, Conjugate, Generating functions, A theorem of Jacobi, Theorem 353 and 354, Applications of theorem 353. Congruence properties of P(n), Two theorems of Euler, Rogers - Ramanujan Identities (portion to be covered as per Chapter-XIX of "An Introduction to the Theory of Numbers" written by G. H. Hardy and E. M. Wright.). 18 Hrs.

TEXT BOOKS

1. T. M. Apostol: Introduction to Analytical number theory, Oxford University Press, 2000.
2. G. H. Hardy and E. M. Wright: An introduction to the Theory of Numbers, Oxford University Press, 1996.
3. Thomas Keshy: Elementary Number Theory with Applications Acad. Press, 2005.

REFERENCE BOOKS

1. I. Niven and H. S. Zuckerman: An introduction to the Theory of Numbers, John Wiley, 2002.
2. J. V. Uspensky and M. A. Heaslott: Elementary Number Theory, McGraw-Hill, 1996.

M403T (D)	Entire and Meromorphic Functions	4 hours/week (52 hours)	4 Credits

Unit-1: Basic properties of Entire Functions. Order and Type of an Entire Functions .Relationship between the Order of an Entire Function and its Derivative . Exponent of Convergence of Zeros of an Entire Function. Picard and Borel's Theorems for Entire Functions. 14 Hrs.

Unit-2: Asymptotic Values and Asymptotic Curves. Connection between Asymptotic and various Exceptional Values**.** 6 Hrs

Unit-3: Meromorphic Functions. Nevanlina's Characteristic Function. Cartan's Identity and Convexity Theorems. Nevanlinna's First and Second Fundamental Theorems .Order and Type of a

Meromorphic Function. Order of a Meromorphic Function and its Derivative. Relationship between T(r, f) and log M(r, f) for an Entire Function. Basic properties of T(r, f**).** 16 Hrs.

Unit-4: Deficient Values and Relation between various Exceptional Values. Fundamental Inequality of Deficient Values. Some Applications of Nevanlinna's Second Fundamental theorem. Functions taking the same values at the same points. Fix-points of Integral Functions**.** 16 Hrs.

TEXT BOOKS

1. A.I. Markushevich: Theory of Functions of a complex Variables, Vol.-II, Prentice-Hall, (1965)
2. A.S.B. Holland: Introduction to the theory of Entire Functions, AcademicPress, NewYork (1973)

REFERENCE BOOKS:

1. C. L. Siegel: Nine Introductions in Complex Analysis, North Holland, (1981)
2. W. K. Hayman: Meromorphic Functions, Oxford University, Press, (1964).
3. Yang La : Value Distribution Theory, Springer Verlag, Scientific Press, (1964).
4. Laine: Nevanlinxa theory & Complex Differerntial Equations, Walter de Gruyter, Berlin (1993)

M 403T (E)	**Magnetohydrodynamics**	**4 hours/week (52 hours)**	**4 Credits**

Unit-1: Electrodynamics: Electrostatics and electromagnetic units – derivation of Gauss law-Faraday's law- Ampere's law and solenoidal property-conservation of charges-electromagnetic boundary conditions. Dielectric materials. 13 Hrs.

Unit-2: Basic Equations: Derivation of basic equations of MHD - MHD approximations - Non-dimensional numbers – Boundary conditions on velocity, temperature and Magnetic field. 7 Hrs.

Classical MHD: Alfven's theorem - Frozen - in - phenomenon - illustrative examples - Kelvin's circulation theorem-Bernoulli's equations - Analogue of Helmholtz vorticity equation-Ferraro's law of isorotation. 6 Hrs.

Unit-3: Magnetostatics: Force free magnetic field and important results thereon-illustrative examples on abnormality parameter-Chandrasekhar's theorem-Bennett pinch and instabilities associated with it. Alfven waves: Lorentz force as a sum of two surface forces- cause for Alfven waves-applications.

7 Hrs

Flow Problems: Hartmann flow- Hartmann–Couette flow- Temperature distribution for these flows. 7 Hrs.

Unit-4: Alfven wave equations in incompressible fluids-equipartition of energy - experiments on Alfven waves-dispersion relations - Alfven waves in compressiblefluids- slow and fast waves-Hodographs. 12 Hrs.

TEXT BOOKS:

1. T.G. Cowling : Magnetohydrodynamics, Interscience, 1957.
2. V.C.A .Ferraro and C. Plumpton: An Introduction to Magneto-Fluid Mechanics, Oxford University Press, 1961.
3. G.W. Sutton and A. Sherman : Engineering Magnetohydrodynamics, McGraw Hill, 1965.
4. Alan Jeffrey: Magnetohydrodynamics, Oliver & Boyd, 1966.
5. K.R. Cramer and S.I. Pai: Magnetofluid Dynamics for Engineers and Applied Physicists, Scripta Publishing Company, 1973.

REFERENCE BOOKS:

1. D.J. Griffiths: Introduction to Electrohydrodynamics, Prentice Hall, 1997.
2. P.H. Roberts: An Introduction to Magnetohydrodynamics, Longman, 1967.
3. H.K. Moffat: Magnetic field generation in electrically conducting fluids, Cambridge University Press, 1978.

M 403T (F)	Fluid Dynamics of Ocean and Atmosphere	4 hours/week(52 hours)	4 Credits

Unit-1: Introduction: Fundamental concepts – Density stratification – Equations of Motion in a rotating Coordinate frame – Coriolis acceleration, Circulation – Vorticity equation - Kelvin's theory – potential vorticity (standard results) – Thermal wind – Geostrophic motion. Hydrostatic approximation, Consequences. Taylor - Proudman theorem Geostrophic Degeneracy. Dimensional analysis and nondimensional numbers. 9 Hrs.

Unit-2: Physical Meteorology: Atmospheric composition, laws of thermodynamics of the atmosphere, adiabatic process, potential temperature. The Clausius Clapyeron equation. Laws of black body radiation, solar and terrestrial radiation, solar constant, Albedo, greenhouse effect, heat balance of earth- atmosphere system. 10 Hrs.

Unit-3: Atmospheric Dynamics: Geostrophic approximation. Pressure as a vertical oordinate. Modified continuity equation. Balance of forces. Non-dimensional numbers (Rossby, Richardson, Froude, Ekman etc). Scale analysis for tropics and extra - tropics, vorticity and divergence equations, conservation of potential vorticity. Atmospheric turbulence and equations for planetary boundary layer. 11 Hrs.

Unit-4: Homogeneous Models of the wind-driven Oceanic circulation: The Homogeneous model - The Sverdrup relation. General Circulation of the Atmosphere:- Definition of the general circulation, various components of the general circulation – zonal and eddy angular momentum balance of the atmosphere, meridional circulation, Hadley Ferrel and polar cells in summer and winter, North-South and East-West (Walker) monsoon circulation. Forces meridional circulation due to heating and momentum transport. Available potential energy, zonal and eddy energy equations. 12 Hrs.

Unit-5: Atmospheric Waves and Instability: Wave motion in general. Concept of wave packet, phase velocity and group velocity. Momentum and energy transports by waves in the horizontal and vertical directions. Equatorial, Kelvin and mixed Rossby gravity waves. Stationary planetary waves. Filtering of sound and gravity waves. Linear barotropic andbaroclinic instability. 10 Hrs.

TEXT BOOKS

1. Joseph Pedlosky : Geophysical fluid Dynamics, Springer, Second Edition, 1987
2. G.K. Batchelor : An introduction to fluid Dynamics, Cambridge University Press, 1967
3. H. Schlichting : Boundary layer theory, Mc Graw Hill, 1968
4. A. Defant : Physical Occanognaphy, Vol.1 Pergamon Press, 1961
5. J.D. Cole : Perturbation methods in applied mathematics, Blaisedell, 1968

REFERENCE BOOKS

1. M. Van Dyke: Perturbation methods in fluid mechanics, Acad, Press, 1964
2. J.R. Holton : An introduction to Dynamic Meteorology, Acad. Press, 1991.
3. Ghill and Childress: Topics in Geophysical Fluid Dynamics, Applied Mathematical Science, Springer Verlag, 1987
4. E. E. Gossard and W.H. Hooke : Waves in the Atmosphere, Elsevier, 1975
5. John Houghton: The Physics of Atmospheres, Cambridge University Press (3rdedition), 2002

M403 T (G)	Computational Fluid Dynamics	4 hours/week (52 hours)	4 Credits

Review of partial differential equations, numerical analysis, fluid mechanics 4 Hrs.

Unit-1: Finite Difference Methods: Derivation of finite difference methods, finite difference method to parabolic, hyperbolic and elliptic equations, finite difference method to nonlinear equations, coordinate transformation for arbitrary geometry, Central schemes with combined space-time discretization-Lax-Friedrichs, Lax-Wendroff, MacCormack methods, Artificial compressibility method, pressure correction method - Lubrication model, Convection dominated flows – Euler equation – Quasilinearization of Euler equation, Compatibility relations, nonlinear Burger equation. 18 Hrs.

Unit-2: Finite Volume Methods: General introduction, Node-centered-control volume, Cellcentered-control volume and average volume, Cell-Centred scheme, Cell-Vertex scheme, Structured and Unstructured FVMs, Second and Fourth order approximations to the convection and diffusion equations (One and Two-dimensional examples). 12 Hrs.

Unit-3: Finite Element Methods: Introduction to finite element methods, one-and two dimensional bases functions – Lagrange and Hermite polynomials elements, triangular and rectangular elements, Finite element method for one-dimensional problem: model boundary value problems, discretization of the domain, derivation of elemental equations and their connectivity, composition of boundary conditions and solutions of the algebraic equations. Finite element method for two-dimensional problems: model equations, discretization, interpolation functions, evaluation of element matrices and vectors and their assemblage. 18 Hrs.

TEXT BOOKS

1. T. J. Chung: 'Computational Fluid Dynamics', Cambridge Univ. Press, 2003.
2. J Blazek, 'Computational Fluid Dynamics', Elsevier, 2001.
3. Harvard Lomax, Thomas H. Pulliam, David W Zingg, 'Fundamentals of Computational Fluid Dynamics', NASA Report, 2006.

REFERENCE BOOKS

1. C.A J. Fletcher: 'Computational techniques for Fluid Dynamics', Vol. I & II, Springer Verlag 1991.

M403 T (H)	Finite Element Method with Applications	4 hours/week(52 hours)	4 Credits

Unit-1: Weighted Residual Approximations:- Point collocation, Galerkin and Least Squares method. Use of trial functions to the solution of differential equations. 10 Hrs.

Unit-2: Finite Elements: One dimensional and two dimensional basis functions, Lagrange and serendipity family elements for quadrilaterals and triangular shapes. Isoparametric coordinate transformation. Area coordinates standard 2- squares and unit triangles in natural coordinates.14 Hrs.

Unit-3: Finite Element Procedures: Finite Element Formulations for the solutions of ordinary and partialdifferential equations: Calculation of element matrices, assembly and solution of linear equations. 14 Hrs.

Unit-4: Finite Element solution of one dimensional ordinary differential equations, Laplace and Poisson equations over rectangular and nonrectangular and curved domains. Applications to some problems in linear elasticity: Torsion of shafts of a square, elliptic and triangular cross sections. 14 Hrs.

TEXT BOOKS

1. O.C. Zienkiewiez and K. Morgan: Finite Elements and approximation, John Wieley, 1983
2. P.E. Lewis and J.P. Ward : The Finite element method- Principles and applications, Addison Weley, 1991 L.J. Segerlind : Applied finite element analysis (2nd Edition), John Wiley, 1984

REFERENCE BOOKS:

1. O.C. Zienkiewicz and R.L. Taylor : The finite element method. Vol. 1 Basic formulation and Linear problems, 4th Edition, New York, Mc. Graw Hill, 1989.
2. J.N. Reddy: An introduction to finite element method, New York, Mc. Graw Hill, 1984.
3. D.W. Pepper and J.C. Heinrich : The finite element method, Basic concepts and applications, Hemisphere, Publishing Corporation, Washington, 1992.
4. S.S. Rao : The finite element method in Engineering, 2nd Edition, Oxford, Pergamon Press, 1989.
5. D. V. Hutton, fundamental of Finite Element Analysis, 2004.
6. E.G. Thomson, Introduction to Finite Elements Method, Theory Programming and applications, Wiley Student Edition, 2005.

M403 T (I)	**Graph Theory**	**4 hours/week (52 hours)**	**4 Credits**

Graph Theory (Recapitulation): Graph, subgraphs, spanning and induced subgraph, degree, distance, standard graphs, Graph isomorphism. 4 Hrs.

Unit-1: Connectivity: Cut-vertex, Bridge, Blocks, Vertex-connectivity, Edge-connectivity and some external problems, Mengers Theorems, Properties of n-connected graphs with respect to vertices and edges. 6 Hrs.

Unit-2: 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. 6 Hrs.

Unit-3: Colorability: 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. 12 Hrs.

Unit-4: 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. 12 Hrs.

Unit-5: Domination concepts and other variants: Dominating sets in graphs, domination number of standard graphs, Minimal dominating set, Bounds of domination number in terms of size, order, degree, diameter, covering and independence number, Domatic number, domatic number of standard graphs. 6 Hrs.

Unit-6: Directed Graphs: Preliminaries of digraph, Oriented graph, indegree and outdegree, Elementary theorems in digraph, Types of digraph, Tournament, Cyclic and transitive tournament, Spanning path in a tournament, Tournament with a hamiltonian path, strongly connected tournaments. 6 Hrs.

TEXT BOOKS

1. F. Harary: Graph Theory, Addison -Wesley, 1969
2. G. Chartrand and Ping Zhang: Introduction to Graph Theory. McGraw Hill, International edition, 2005
3. J. A. Bondy and V.S.R. Murthy: Graph Theory with Applications, Macmillan, London, 2004.
4. T.W. Haynes, S.T. Hedetneime and P. J. Slater: Fundamental of domination in graphs, Marcel Dekker. Inc. New York.1998.

REFERENCE BOOKS

1. D. B. West, Introduction to Graph Theory, Pearson Education Asia, 2nd Edition, 2002
2. Charatrand and L. Lesnaik-Foster: Graph and Digraphs, CRC Press (Third Edition), 2010
3. J. Gross and J. Yellen: Graph Theory and its application, CRC Press LLC, Boca Raton, Florida, 2000
4. Norman Biggs: Algebraic Graph Theory, Cambridge University Press (2nd Ed.)1996
5. Godsil and Royle: Algebraic Graph Theory: Springer Verlag, 2002
6. N. Deo: Graph Theory: Prentice Hall of India Pvt. Ltd. New Delhi - 1990
7. V. R. Kulli, Theory of domination in graphs, Vishwa Int. Pub. 2012

M403 T (J)	Design and Analysis of Algorithms	4 hours/week (52 hours)	4 Credits

Unit-1: 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, little-omega, theta functions, illustrations. Inter-relations between different growth functions and comparison. Basic data structures: Lists, Stacks, Queues, Trees, Graphs, Heaps, examples and applications. 10 Hrs

Unit-2: 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. 7 Hrs

Unit-3: Graph Algorithms: Depth-First search, breadth-first search, backtracking, branch-and-bound, etc. 7 Hrs

Unit-4: 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. 8 Hrs

Unit-5: 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). 12 Hrs

Unit-6: Introduction to *NP*-completeness: Polynomial time reductions, verifications, verification algorithms, classes *P* and *NP*, *NP*-hard and *NP*-complete problems. 8 Hrs

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 NP-Completeness, W. H. Freeman, San Francisco, 1976.
3. R. Sedgewick, Algorithms in C++, Addison- Wesley, 1992.

M404 P	Latex and Latex Beamer Practicals	2 hours/week	1 Credit

1. Using environment, type the following text

1. Numbering 1

a. Type 1

• bullet 1

• bullet 2

b. Type 2 obullet typecircle 1 bullet type circl 2

2. Numbering 2

i. Type 3

 Bullet type rectangles

2. Display the following

i. Roman letters I, II, III, IV so on and i, ii, iii, iv so on ii. Alphabetics a, b, c, d, so on iii. Uppercase alphabetics A, B, C, iv. Include special symbols @, $, %, &, ×, (), {}, \, /, #, !

v. Include Mathematical symbols Δ, π, φ, ∞, μ, α, η, θ, λ, ξ, χ, τ, σ, β, Ω, Ψ, ϒ, ϑ ect.,

3. Write and Display Mathematical Equations

4. Create a table in different forms

5. Import figures and graphs into latex document

6. Draw different figures using latex commands

7. Create frames in different formats

8. Create frames containing mathematical expressions

9. Create frames containing tables and figures

10. Create Bibliography in frames

TEXT BOOKS / OPEN SOURCE MATERIALS

1. Charles T. Batts : A Beamer Tutorial in Beamer. (**http://www.ctan.org/tex-archive/macros/latex/contrib/beamer/doc/**)

2. **http:/latex-beamer.sourceforge.net.**

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