ಅರು ನೀ ಅನಿಕೇತನ

BE BOUNDLESS

BENGALURU CITY UNIVERSITY

SYLLABUS FOR M.Sc Mathematics
(I to IV Semester)

CHOICE BASED CREDIT SYSTEM
(SEMESTER SCHEME)

2020-2021

MISSION AND VISION OF THE NEW SYLLABUS IN MATHEMATICS

Mission

Improve retention of mathematical concepts in the student.

- To develop a spirit of inquiry in the student.
- To improve the perspective of students on mathematics as per modern requirement.
- To initiate students to enjoy mathematics, pose and solve meaningful problems, to use abstraction to perceive relationships and structure and to understand the basic structure of mathematics.
- To enable the teacher to demonstrate, explain and reinforce abstract mathematical ideas by using concrete objects, models, charts, graphs, pictures, posters with the help of FOSS tools on a computer.
- To make the learning process student-friendly by having a shift in focus in mathematical teaching, especially in the mathematical learning environment.
- Exploit techno-savvy nature in the student to overcome math-phobia.
- Propagate FOSS (Free and open source software) tools amongst students and teachers as per vision document of National Mission for Education.
- To set up a mathematics laboratory in every college in order to help students in the exploration of mathematical concepts through activities and experimentation.
- To orient students towards relating Mathematics to applications.

Vision

- To remedy Math phobia through authentic learning based on hands-on experience with computers.
- To foster experimental, problem-oriented and discovery learning of mathematics.
- To show that ICT can be a panacea for quality and efficient education when properly integrated and accepted.
- To prove that the activity-centered mathematics laboratory places the student in a problem solving situation and then through self exploration and discovery habituates the student into providing a solution to the problem based on his or her experience, needs, and interests.
- To provide greater scope for individual participation in the process of learning and becoming autonomous learners.
- To provide scope for greater involvement of both the mind and the hand which facilitates cognition.
- To ultimately see that the learning of mathematics becomes more alive, vibrant, relevant and meaningful; a program that paves the way to seek and understand the world around them. A possible by-product of such an exercise is that math-phobia can be gradually reduced amongst students.
- To help the student build interest and confidence in learning the subject.

Scheme of Instruction and Examination

<table>
<tr><th colspan="10">I Semester</th></tr>
<tr><th rowspan="2">Subjects</th><th rowspan="2" colspan="2">Papers</th><th rowspan="2">Instruction hrs/week</th><th rowspan="2">Duration of Exam (hrs)</th><th colspan="3">Marks</th><th rowspan="2">Credits</th></tr>
<tr><th>IA</th><th>Exam</th><th>Total</th></tr>
<tr><td rowspan="5">Core Subject</td><td rowspan="5">Theory</td><td>M101T: Algebra-I</td><td>4</td><td>3</td><td>30</td><td>70</td><td>100</td><td>4</td></tr>
<tr><td>M102T: Real Analysis</td><td>4</td><td>3</td><td>30</td><td>70</td><td>100</td><td>4</td></tr>
<tr><td>M103T: Topology-I</td><td>4</td><td>3</td><td>30</td><td>70</td><td>100</td><td>4</td></tr>
<tr><td>M104T: Ordinary Differential Equations</td><td>4</td><td>3</td><td>30</td><td>70</td><td>100</td><td>4</td></tr>
<tr><td>M105T:Discrete Mathematics</td><td>4</td><td>3</td><td>30</td><td>70</td><td>100</td><td>4</td></tr>
<tr><td colspan="2">Practicals</td><td>M106P: Maxima practicals based on paper M105T</td><td>4</td><td>3</td><td>15</td><td>35</td><td>50</td><td>2</td></tr>
<tr><td>Soft Core</td><td>Theory</td><td>M107SC: Mathematical Analysis</td><td>3</td><td>3</td><td>30</td><td>70</td><td>100</td><td>2</td></tr>
<tr><td colspan="8">Total of Credits</td><td>24</td></tr>
</table>

II Semester

Subjects		Papers	Instruction hrs/week	Duration of Exam (hrs)	Marks			Credits
					IA	Exam	Total	
Core Subjects	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
		M 205T: Numerical Analysis	4	3	30	70	100	4
Practicals		**M206P:** Scilab Practicals based On M205T	4	3	15	35	50	2
Soft Core Theory		**M 207SC :** Elementary Number Theory	3	3	30	70	100	2
						Total of Credits		**24**

III Semester									
Subjects	Papers		Instruction hrs/week	Duration of Exam (hrs)	Marks			Credits
					IA	Exam	Total	
Core Subject	Theory	**M 301T:** Liner Algebra	4	3	30	70	100	4
		M 302T: Functional analysis	4	3	30	70	100	4
		M303T: Differential Geometry	4	3	30	70	100	4
		M304T: Fluid Mechanics	4	3	30	70	100	4
		M 305T: Numerical Analysis-II	4	3	30	70	100	4
Practicals		**M306P:** Scilab Practicals based on M305T	4	3	15	35	50	2
Open Electives	Elective 1	**M 307OE(A):** Elements of calculus	4	3	30	70	100	4
	Elective 2	**M 307OE (B):** Mathematics for Everyone						
							Total of Credits	**26**

IV Semester								
Core Subject and Electives	Compulsory Theory	**M 401T** Measure And Integration	4	3	30	70	100	4
		M402T Mathematical Methods	4	3	30	70	100	4
	Electives (Choose any 4)	**M 403T A** Riemannian Geometry	4x 4	4 x 3	4X 30	4 X 70	4 X 100	4X 4
		M 403T B Special Functions						
		403T C Entire And Meromorphic Functions						
		M 403T D Magnetohydrodynamics						
		M-403T E Computational Fluid Dynamics						
		M 403T F Finite Element Methods with Applications						
		M 403T G Graph Theory						
		M 403T H Design and Analysis Of Algorithms						
		M403T I Codes, Designs and Networks						
		M403TJ Algebraic Combinatorics						
		M403T K Modelling and Simulation						
		M403T L Flight Dynamics						
	Practicals	M404P: Latex and Latex Beamer	4	3	15	35	50	2
							Total of Credits	**26**
							Program Grand total of credits	**100**

In the first two semesters there are 4 core papers, one practical paper and 1 soft core paper. In each semester total credits are 24. 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. The other courses are offered to the students of the department. In the fourth semester, the core subjects'M401T' and 'M402T' are compulsory and the student can choose any four (4) core papers from M403T(A) – (L). An elective paper can be offered only of there are a minimum of 05 students.

Scheme of evaluation:

Internal assessment marks for theory for 30 marks

Two internal tests: 30 marks

Internal assessment marks for practical for 15 marks

Two internal tests: 15 marks

Break-up of practical mark allotment for 35 marks

Practical Record	: 5 marks
Actual Practicals	: 24 marks
Viva	: 06 marks

Syllabi of Each Semester

FIRST SEMESTER

M101T	ALGEBRA-I	4 Credits (52 Hours)

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

Sylow's groups and subgroups, Sylow's theorems for a finite group, Applications and examples of p-Sylow subgroups. Solvable groups, Simple groups, Applications and examples of solvable and simple groups, Jordan –Holder Theorem. **13 Hrs.**

Ring Theory (Recapitulation): Rings, Some special classes of rings (Integral domain, division ring, field).
Homomorphisms of rings, Kernel and image of Homomorphisms of rings, Isomorphism of rings, Ideals and Quotient rings, Fundamental theorem of homomorphism of rings,Theorems on principle, maximal and prime ideals, Field of quotients of an integral domain, Imbedding of rings. **13 Hrs.**

Euclidean rings, Prime and relatively prime elements of a Euclidean ring, Unique factorization theorem, Fermat's theorem, Polynomial rings, The division algorithm. Polynomials over the rational field, Primitive polynomial, Content of a polynomial. Gauss lemma, Eisenstein criteria, Polynomial rings over commutative rings, Unique Factorization Domains. **13 Hrs.**

TEXT BOOKS

1. I. N. Herstein, Topics in Algebra, 2nd Edition, John Wiley and Sons, 2007.
2. Surjeet Singh and QaziZameeruddin, Modern Algebra, Vikas Publishing House, 1994.
3. N. Jacobson , Basic Algebra-I, 2nd ed., Dover Publications, 2009.

REFERENCE BOOKS

1. M. Artin : Algebra, Prentice Hall of India, 1991.
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, 7th ed., Addison-Wesley Longman, 2002.

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

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. First and second mean value Theorems, Change of variable rectifiable curves. **18 Hrs.**

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- Equi-continuous families of functions, uniform convergence and boundedness, 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. **18 Hrs.**

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. **16 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

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). **13Hrs.**

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. **13 Hrs.**

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. **13 Hrs.**

Continuity and homeomorphism, Pasting lemma. Connected spaces: Definition and examples, connected sets in the real line, Intermediate value theorem, components and path components, local connectedness and path connectedness.

13 Hrs.

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

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.

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.

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 equationsand their general solutions. Generating function, Recurrence relations, Rodrigue'sformulaOrthogonality properties. Behaviour of solution at irregular singular points and the point at infinity.

13 Hrs.

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, NewYork, 1984.

REFERENCE BOOKS

1. E.D. Rainville and P.E. Bedient : Elementary Differential Equations, McGraw Hill, New York, 1969.

2. E.A. Coddington and N. Levinson: Theory of ordinary differential equations, McGraw Hill, 1955.
3. A. C. King, J. Billingham and S. R. Otto: Differential equations, Cambridge University Press, 2006.

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

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.
Counting Techniques: The product rule, The sum rule, The inclusion–exclusion principle, The Pigeonhole Principle and examples.Simplearrangements and selections, Arrangements and selections with repetitions, Distributions, Binomial Coefficients. **13 Hrs.**

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.
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. **13 Hrs.**

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. 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. **13 Hrs.**

Planarity in graphs, Euler's Polyhedron formula. Kuratowski's theorem (statement only).Vertex connectivity, Edge connectivity, covering, Independence.
Trees, Rooted trees, Binary trees, Trees as models. Properties of trees. Minimum spanning trees. Minimum spanning trees. Prim's and Kruskul's Algorithms. **13 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 and 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	4hours/week	2 Credits

List of Programs

1. Basics of Maxima- 4hours.
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.

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 and R. M. Wilson, "'A course on Combinatorics", Cambridge University Press (2006).
4. Allan Tucker, "Applied Combinatorics", John Wiley & Sons (1984).

M107SC	Mathematical Analysis	3 hours/week(39 hours)	2 Credits

Recap of limits, continuity and differentiability of functions, Continuity and compactness, Continuity and connectedness, Infinite limits and limits at infinity, Mean value theorems,The continuity of derivatives, Derivatives of higher order, Taylor's theorems, Differentiation of vector valued functions.

13 Hrs.

Numerical sequences and series of real numbers, convergent sequences, Cauchy sequences, upper and lower limits, Some special sequences, Series, Series of non-negative terms, The number e, tests of convergence, Power series, Summation by parts, Absolute convergence, Addition and multiplication of series, Rearrangements.re-arrangements. Double series, infinite products.

17 Hrs.

Topology of R^n, K-cell and its compactness, Heine-Borel Theorem. Bolzano Weierstrass theorem, Continuity, Compactness and uniform continuity. **9 Hrs.**

TEXT BOOKS

1. W. Rudin – Principles of Mathematical Analysis, International Student edition, McGraw Hill, 3rd Ed.
2. T. M. Apostal – Mathematical Analysis, Addison Wesley, Narosa, New Delhi, 2nd Ed.

REFERENCE BOOKS

1. R. R. Goldberg – Methods of real Analysis, Oxford and IBH, New Delhi.
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, SpringerInternational 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).
Local ring, the nil radical and Jacobson, radical, operation on ideals, extension and contraction. The prime spectrum of a ring.
Modules Theory: Modules, submodules and quotient modules, modules homomorphisms, Isomorphism theorems of modules. **13 Hrs.**

Direct sums, Free modules Finitely generated modules, Nakayama Lemma, Simple modules, Exact sequences of modules.
Modules with chain conditions - Artinian and Noetherian modules, modules of finite length, Artnian rings, Noetherian rings, Hilbert basis theorem. **13 Hrs.**

Filed Theory: Extension fields, Finite and Algebraic extensions. Degree of extension, Algebraic elements and algebraic extensions, Adjunction of an element of a field.
Roots of a polynomial, Splitting fields, Construction with straight edge and compass. **13 Hrs.**

More about roots (Characteristic of a field), Simple and separable extensions, Finite fields
Galois Theory: Elements of Galois Theory, Fixed fields, Normal extension, Galois groups over the rationals, degree, distance. **13 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

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 adisk, Zeros of Analytic function. The index of a closed curve, counting of zeros. Principles of analytic Continuation. Liouville's Theorem, Fundaments theorem of algebra.

13 Hrs.

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. Rational Functions, Singularities, Poles, Classification of Singularities, Characterization of removable Singularities, poles. Behaviour of an Analytic functions at an essential singular point. **13Hrs.**

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.

13 Hrs.

Convex functions, Hadmard's Three circle theorem. 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. **13 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. Ponnaswamy: Functions of Complex variable, Narosa Publications

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

Compact spaces, Compact sets in the real line, limit point, compactness, sequential compactness and their equivalence for metric spaces. Locally Compact spaces, compactification, Alexandroff'sone point compactification. The axioms of countability: First axiom space, Second countable space, Separability and the Lindelof property and their equivalence for metric spaces. **13 Hrs.**

The product topology, the metric topology, the quotient topology, Product invariant properties for finite products, Projection maps. Separation axioms: T_0– space and T_1 spaces –definitions and examples, the properties are hereditary and topological. Characterization of T_0 - and T_1 –spaces. **13 Hrs.**

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. Normality and the T_4 - axiom, Metric space is T_4, compact Hausdorff space and regular Lindelof spaces are normal. **13 Hrs.**

Urysohn's Lemma, Tietze's Extension Theorem, Complete regularity, Complete normality and the T_5 - axiom. Local finiteness, Paracompactness, Normality of a paracompact space, Metrizability, Urysohn metrization theorem, **13 Hrs.**

TEXT BOOKS

1. J.R. Munkres, Topology, 2nd Ed., Pearson Education (India), 2001.
2. W.J. Pervin : Foundations of General Topology - Academic Press, 1964.

REFERENCE BOOKS

1. G. F. Simmons: Introduction to Topology and Modern Analysis, (McGraw-Hill International Edition).
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

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. **13 Hrs.**

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. **13 Hrs.**

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

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 **13 Hrs.**

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

13 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

Solution of nonlinear equation in one variable

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.

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.

13hours

Solving system of equations

Review of matrix algebra. Gauss-elimination with pivotal strategy. Factorization methods (Cvout's, DoolittleandCholesky). 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.

Interpolation **13hours**

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.

13 hours

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. Adaptive quadratures.

13hours

TEXT BOOKS

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

REFERENCE BOOKS

4. A Iserles: A first course in the numerical analysis of differential equations, Cambridge texts in applied mathematics, 2008, 2 edition.
5. J Stoer and R Bulirsch, Introduction to Numerical Analysis, Springer, New York, 2 edition.
6. Semyon V. Tsynkov and Victor S. Ryaben'kii, A Theoretical Introduction to Numerical Analysis, Chapman and Hall /CRC, USA, 2007.

M206P	Scilab Practicals based on M205T	4 hours/week	2 Credits

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

Program on numerical integration using

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

Text books

1. SD Cante and C de Boor: Elementary numerical analysis, Tata-Mc Graw-Hill, 1980,3 edition.
2. RL Burden and JD Faires: Numerical Analysis, Thomson-Brooks/Cole, 1989, 7 edition.
3. D Kincade and W Cheney: Numerical analysis, American Mathematical Society, 2002, 3 edition.
4. A Iserles: A first course in the numerical analysis of differential equations, Cambridge texts in applied mathematics, 2008, 2 edition.

M207SC	Elementary Number Theory	3 hours/week(39 hours)	2 Credits

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.

10 Hours

Congruences :

Recapitulation of basic properties of congruences, Residue classes and complete residue systems,Linearcongruences. 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.

10 Hours

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.

10 Hours

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 $n = 4$).

09 Hours

REFERENCES

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

THIRD SEMESTER

M301T	Liner Algebra	4 hours/week(52 hours)	4 Credits

Recapitulation: Vector Spaces, Subspaces, Direct sums, Linear transformation, Linear Operators. Algebra of Linear transformations, Minimal polynomials, Regular and singular transformation, Range and rank of a transformation and its properties, characteristic roots and characteristic vectors. 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. Characteristic polynomials, Diagonalizability, Invariant subspaces, Cayley-Hamilton theorem.

26 Hrs.

Canonical Forms: Triangular canonical form, Nilpotent transformations, Jordan canonical form, The rational canonical forms. Inner Product Spaces, Orthogonal complements, Gram-Schmidt orthonormalization process. Positive Definite Matrices, Maxima, minima and saddle points, Tests for positive definiteness,
Singular value Decomposition and its applications. Bilinear forms, symmetric and skew-symmetric bilinear forms, real quadratic forms, rank and signature, Sylvester's law of inertia. **26 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, 3Edition, 2003.
4. L. Hogben-Handbook of Linear Algebra-Chapman and Hall-CRC (2006).

M302T	Functional Analysis	4 hours/week(52 hours)	4 Credits

Normed linear spaces. BanachSpaces: 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. 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. **13 Hrs.**

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. **13 Hrs.**

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. 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. **13 Hrs.**

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. 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. **13 Hrs.**

TEXT BOOKS

1.G. F. Simmons: Introduction to Topology and Modern Analysis (McGraw-Hill Intl. Edition), 1998.

REFERENCE BOOKS

1. G. Backman and L. Narici : Functional Analysis (Academic), 2006.
2. B. V. Limaye : Functional Analysis (Wiley Eastern), 1998.
3. P.R. Halmos : Finite dimensional vector paces, Van Nostrand, 1958.
4. E. Kreyszig : Introduction to Functional Analysis with Applications, John Wiley & Sons, 2000.

M303T	Differential Geometry	4 hours/week(52 hours)	4 Credits

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.

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 FrenetformulasFrenet 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.

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.

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.

M304T	Fluid Mechanics	4 hours/week(52 hours)	4 Credits

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.

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. **13 Hrs.**

Fundamental basic physical laws- Law of conservation of mass - Principles of linear and angular momenta - Balance of energy - Examples.

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. **13 Hrs.**

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. **13 Hrs.**

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 theorem and 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.

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

Numerical solution of ordinary differential equations

Examples from ODE where analytical solution are difficult or impossible.

Initial value problems: Picard's method, Implicit Runge-Kutta fourth order: derivation, error analysis; Methods for systems and higher order ODEs, Runge-Kutta-Fehlberg methods. Stability of these schemes; Multistep methods- the Adams-Bashforth and Adams-Moulton predictor-Corrector methods. Variable step size; Local and global errors, stability analyses for these methods; Solution of linear ODEs through eigenfunction approach. **13 Hrs.**

Boundary value problems: Shooting methods: Linear and nonlinear; Cubic spline methods, Rayliegh Ritz methods, Galarkin Method, Chebyshev collocation methods, Finite difference methods. **13 Hrs.**

Numerical solution of partial differential equations:
Examples from PDE where analytical solution are difficult or impossible.
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. Stability and convergence analyses for these schemes. **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 these schemes. **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. JW Thomas : Numerical partial differential equations: finite difference methods, Springer, 1998, 2 Edition.

REFERENCE BOOKS

4. A Iserles: A first course in the numerical analysis of differential equations, Cambridge texts in applied mathematics, 2008, 2 edition.
5. GD Smith: Numerical solution of partial differential equations: finite difference methods Oxford Applied Mathematics and Computing Science Series, 1985 3rd Edition.

M 306P	**Scilab Practicals based on M305T**	**4 hours/week**	**2 Credits**

List of Programs

Programs for solution of ordinary differential equations using

1. Implicit Runge-Kutta 4 order method
2. Runge-Kutta-Fehlberg order method
3. Runge-Kutta for system of equations
4. Adam's Predictor-corrector method
5. Shooting methods
6. Galarkin method
7. Rayleigh Ritz method
8. Chebyshev collocation method
9. Finite difference method

Programs for solution of partial differential equations using

10. Laplace equation
11. Poisson equation
12. Schmidt Method

13. Crank-Nicolson method
14. ADI method
15. Explicit method for wave equation
16. Lees ADI method for wave equation

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. D Kincade and W Cheney: Numerical analysis, American Mathematical Society, 2002, 3 edition.
4. A Iserles: A first course in the numerical analysis of differential equations, Cambridge texts in applied mathematics, 2008, 2 edition.
5. GD Smith: Numerical solution of partial differential equations: finite difference methods Oxford Applied Mathematics and Computing Science Series, 1985 3rd Edition.
6. JW Thomas : Numerical partial differential equations: finite difference methods, Springer, 1998, 2 Edition.

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

Differential Calculus: Limit and continuity, properties of limits and classification of discontinuities. Derivatives, Rules for Differentiation, higher order derivatives, chain rule, implicit differentiation. **10 Hrs.**

Successive differentiation and Leibnitz Theorem. Statement of Rolle'sTheorem, Mean Value Theorem, Taylor and Maclaurin'stheorems. **10 Hrs.**

Integral Calculus: Integration. Methods of Integration: substitution method, partial fractions, integration by parts, definite integrals, indefinite integrals. **10 Hrs.**

Applications of differentiation and integration: Increasing and decreasing functions. Relative Extrema : maxima and minima, convexity, curve sketching. **10 Hrs.**

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
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.
2. Courant, R. and F. John, Introduction to Calculus and Analysis, Volume II.

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

Biography of Selected Mathematicians

Indian Mathematicians: Aryabhata, Varahamihira, Bhaskara I & II, Brahmagupta, Mahaviracharya, Nagarjuna, SrinivasaRamanujan. Foreign Mathematicians: Euler, Gauss, Riemann, Euclid,Rene Descartes, Leibnitz, Al-Khwarizmi, Hilbert, Fermat and Cauchy.

8 Hrs.

Basic Concepts in Mathematics

The Number Systems: Natural numbers, Integers, Rational &Irrrational numbers, Real numbers, complex number, Prime number. The concept of Sets: Subsets and Equality of sets, set operations (Union, Intersection and Difference). Equivalence Relations & Types of Functions (One - one, Onto, Many –one functions with examples) Mathematical Logic, Methods of proof, Mathematical Inductions. **8 Hrs.**

Ordered theory

Partial Ordered sets, Hasse diagrams, Isomorphism, Extermal elements in poset, Lattice, Distributive lattice, Complemented lattice, Boolean lattices, Boolean Algebras, Boolean functions, Applications to Switching circuits.

6 Hrs.

Elements of Higher Arithmetic Concepts of divisibility, Congruence's, Residue classes, Theorems of Fermat, Euler and Wilsons, Linear congruence, Chinese Remainder Theorems, Elementary arithmetical functions, Applications of cryptography.

6 Hrs.

Fundamental of Group theory

Groups, subgroups, cyclic groups,Normal subgroups. Quotient groups, homorphisms, Natural homomorphisms. Kernel and image of a homomorphism and their properties. Isomorphism and Fundamental theorem of homomorphism of groups. Application of chemistry.

6Hrs.

Elements of Calculus

Functions of one Variable: Limits, continuity and differentiations of functions of a single variable. Derivative of a composite function, Parametric function, logarithmic function, Exponential and inverse functions. Derivative of higher order. Partial Derivatives and total derivative Homogenous functions and Eulers Theorem.

6 Hrs.

Solid Geometry

Analytical Geometry in three dimensions: Direction cosines and direction ratios, planes, straightlines, angle between planes/ straight lines, coplanar lines, shortest distance between skew lines, right circular cone and right circular cylinder.

6Hrs.

Graph theory

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, Traveling Salesman's Problem.

6Hrs.

TEXT BOOKS

1. C.L. Liu: Elements of Discrete Mathematics, Tata McGraw–Hill, 2000.
2. Ralph P. Grimaldi: Discrete and Combinatorial Mathematics, 4th Edition, Addison-Wesley, 1999
3. Kenneth Rosen: WCB McGraw-Hill, 6th ed., 2004.
4. D. M. Burton: elementary Number theory, Tatsa McGraw-Hill, New Delhi, 6Ed.

REFERENCE BOOKS

1. I.N. Herstein: Topics in Algebra, 2nd Edition, Vikas Publishing House, 1976
2. S. L. Loney: The elements of Coordinate geometry, London Macmillan & Co., 1966.
3. S. Lipschutz and M. Lipson: Theory and Problems of DiscreeMathematics, Schaum series 2nd Tata McGraw Hill, 1998.
4. G. B. Thomas and R. L. Finney, Calculus and Analytical Geometry, 9th Ed., 2012.

FOURTH SEMESTER

M401T	**Measure And Integration**	**4 hours/week(52 hours)**	**4 Credits**

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. Relations between the outer measure of an arbitrary set and the outer measure of open sets and Drsets (Lebesgue) measurable sets, (Lebesgue) measure, Complement, union, intersection and difference of measurable sets, denumerable union, and intersection of measurable sets; Countable sub additivity and additivity of measure; Cantor's set, F_σ and G_δ sets. The class of measurable sets as an algebra, sigma-algebra **13 Hrs.**

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. Measurability of a continuous function and measurability of a continuous image of measurable function. Sequence of functions, Egoroff's theorem. The structure of measurable functions, Lusin theorem, Frechet theorem. Convergence pointwise and convergence in measures of a sequence of measurable functions, Reisz theorem. **13 Hrs**

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. Convergence theorems and Lebesgue integral; The bounded convergence theorem, Fatou's lemma, Monotone convergence theorem, Lebesgue dominated convergence theorem. **13Hrs.**

Differentiation of monotone functions, Vitali covering lemma, Functions of bounded variation, Jordan Decomposition theorem, Differentiability of an integral. Absolute continuity:Absolute continuity, sum, difference, product ,quotient of absolute continuous functions, Absolute continuity and bounded variation, absolute continuity and indefinite integrals. **13 Hrs.**

TEXT BOOKS

1. H.L. Royden : Real Analysis, Macmillan, 1963

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	

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.

13 Hours

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.

13 Hours

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.

13 Hours

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. 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.

13 Hours

Text books:

1. I N Sneddon: The use of Integral Transforms, Tata Mc Graw Hill, Publishing Company Ltd, New Delhi, 1974.
2. RP Kanwal: Linear integral equations theory and techniques, Academic Press, New York, 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. AHNayfeh: Perturbation Methods, John Wiley & sons New York, 1973.

Reference Books:

6. M. D. Raisinghania, Integral equations and Boundary value problems, 6 edition, S Chand and Co., 2013.
7. RV Churchill: Operational Mathematics, Mc. Graw Hill, New York, 1958.

ELECTIVE PAPERS

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

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. **13 Hrs.**

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. **13 Hrs.**

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. **13 Hrs.**

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. **13 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.VanNostrand company Inc. Princeton, New Jersey, New York, London (Affiliated East-West Press Pvt. Ltd. New Delhi), 1998.

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.
5. K. S. Amur, D.J. Shetty and C. S. Bagewadi, An introduction to differential Geometry, Narosa Pub. New Dehli, 2010.

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

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

10 Hrs.

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 $_1\psi_1$ 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.**

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). **8 Hrs.**

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)- $p(5n+4) \equiv 0 \pmod 5$ and $p(7n+4) \equiv 0 \pmod 7$- 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).

20 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. MahadevaNaika 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. MahadevaNaika 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. SarachaiKongsiriwong 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)	Entire and Meromorphic Functions	4 hours/week(52 hours)	4 Credits

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.**

Asymptotic Values and Asymptotic Curves. Connection between Asymptotic and various Exceptional Values. **6 Hrs.**

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.**

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, Academic Press, New York, (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 and Complex Differerntial Equations, Walter de Gruyter, Berlin (1993).

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

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.**

Basic Equations: Derivation of basic equations of MHD - MHD approximations -Non-dimensional numbers – Boundary conditions on velocity, temperature andMagneticfield . **7 Hrs.**

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

Magnetostatics: Force free magnetic field and important results thereon-illustrative examples on abnormality parameter-Chandrasekhar's theorem-Bennett pinch and instabilities associated with it.

7 Hrs.

Alfven waves: Lorentz force as a sum of two surface forces- cause for Alfven waves-applications-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.**

Flow Problems: Hartmann flow- Hartmann –Couette flow- Temperature distributionfor these flows.

7 Hrs.

TEXT BOOKS:

1. T.G.Cowling : Magnetohydrodynamics, Interscience, 1957.
2. V.C.A.Ferraro and C.Plumpton: An Introduction to Magneto-FluidMechanics, 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.

M403T E	Computational Fluid Dynamics	4 hours/week(52 hours)	4 Credits

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

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.

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.

Finite Element Methods: Introduction to finite element methods, one-and twodimensional 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.

M403T F	Finite Element Method with Applications	4 hours/week(52 hours)	4 Credits

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

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.**

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.**

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. GrawHill, 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).

M403T G	Graph Theory	4 hours/week(52 hours)	4 Credits

Graph Theory (Recapitulation): Graph, subgraphs, spanning and induced subgraph, degree, distance, standard graphs, Graph isomorphism.
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.
Planarity: Plane and Planar graphs, Planarity Testing algorithm, Euler Identity, Non planar graphs, Maximal planar graph Outer planar graphs, Maximal outer planar graphs, Characterization of planar graphs, Geometric dual, Crossing number.
13 Hrs.

Colorability: Vertex Coloring, Color class, n-coloring, Chromatic index of a graph, Chromatic number of standard graphs, Bichromatic graphs, Coloring algorithms, 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.
13 Hrs.

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.
13 Hrs.

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.
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. **13 Hrs.**

TEXT BOOKS

1. F. Harary: Graph Theory, Addison -Wesley,1969
2. G. Chartrand and Ping Zhang: Introduction to Graph Theory. McGrawHill, 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

M403T H	Design And Analysis Of Algorithms	4 hours/week(52 hours)	4 Credits

Introduction to Algorithms: Meaning of space and time complexity, illustrations with simple examples. Introduction to growth functions, Asymptotic 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.
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.
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. **26 Hrs.**

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. **26 Hrs**

TEXT BOOKS

1. T. Cormen, C. Leiserson, R. Rivest and 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- WesleLangman Singapore, Ptv. 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.

M403T I	Codes, Designs and Networks	4 hours/week(52 hours)	4 Credits

Enumeration: - Basic counting principles, distributions, binomial identities, generating functions, Equivalence and symmetric groups, Burnside theorem, the cycle index, pattern inventory, Polya's formula. **13hrs**

Codes:- Elements of coding theory, the Hamming metric, the parity-check and generator metrics, group codes, decoding with coset leaders, hamming matrices, self-orthogonal codes, symmetric codes over F_3, problems, *f*-augmenting paths, Max nearly perfect binary codes and uniformly packed codes. **13hrs**

Designs:- Basic concepts, combinatorial designs, examples, block designs, systems of distinct representatives, balanced designs, pair wise balanced designs, balanced incomplete block design (BIBD), partially balanced incomplete block design (PBIBD). **13hrs**

Networks:- Flows and cuts in Networks, solving max Flow problems, Max flow-Min Cut problems, f-augmenting paths, Max flow- Min cut theorem, Algorithms to find augmenting path, Ford, Fulkerson, Edmonds and Karp algorithm to find Max Flow, properties of 0-1 networks. **13hrs**

TEXT BOOKS

1. Alan Tucker, "Applied Combinatorics", 4^{th} Ed., John Wiley and Sons, 2002.
2. R. P. Grimaldi, "Discrete and Combinatorial Mathematics: An applied introduction", 4^{th} Ed., Pearsons Education Inc., 1999.

REFERENCE BOOKS

1. W. D. Wallis, "Combinatorial designs", Marcel Decker,Inc.,NY,1988.
2. C. J. Colbourn and J. H. Dinitz, Handbook of Combinatorial designs, CRC press, 1996.

M403T J	**Algebraic Combinatorics**	**4 hours/week(52 hours)**	**4 Credits**

Preliminaries: Fundamentals of matrix theory, algebraic notations, power series, limits, operations on power series, Exp and Log, non-linear equations, examples.
Characteristic Polynomial: Coefficients and recurrences, walks and the characteristic polynomials, eigenvalues and eigenvectors, regular graphs, spectral decomposition
Walk generating functions: Jacobi theorem, decomposition formula, the Christoffel-Darboux identity, vertex reconstruction, cospectral graphs, random walks on graphs.
Quotients of graphs: Equitable partitions, walk-regular graphs, generalized interlacing, covers, spectral radius of trees
26 Hrs

Strongly regular graphs: Basic theory, conference graphs, designs, orthogonal arrays
Distance regular graphs: Some families, distance matrices, parameters, quotients, imprimitive distance regular graphs, codes, completely regular subsets
Association schemes: Generously transitive permutation groups, *p*'s and *q*'s, *P*- and *Q*-polynomial association schemes, products, primitivity and imprimitivity, codes and anticodes, equitable partitions of matrices, characters of abelian groups, Cayley graphs, translation schemes and duality.
Representations of distance-regular graphs: Representations of graphs, the sequence of cosines, injectivity, eigenvalue multiplicities, bounding the diameter, spherical designs, bounds for cliques, feasible automorphisms.
26 Hrs

TEXT BOOKS:

1. C. D. Godsil: Algebraic Combinatorics, Chapman and Hall/CRC, 1993.

REFERENCE BOOKS:

1. C. D. Godsil and Royle : Algebraic graph theory, Springer Verlag, 2002.
2. Alan Tucker, "Applied Combinatorics", 4th Ed., John Wiley and Sons, 2002.
3. R. P. Grimaldi, "Discrete and Combinatorial Mathematics: An applied introduction", 4th Ed., Pearsons Education Inc., 1999.
4. Norman Biggs: Algebraic Graph Theory, Cambridge University Press (2nd Ed.)1996.

M403T K	Modelling and Simulation	4 hours/week(52 hours)	4 Credits

Concept of mathematical Modeling: Definition, Classification, Characteristics and Limitations.
Models leading to ordinary differential equations: Setting up of first order differential equations from Real world problems – Qualitative solution and sketching for first-order Differential equations – Difference & Differential equation models for population Growth – Growth and Decay Models – single species population models – Spread of Technological innovations – Higher order linear models- spring and dashpot systems – electrical circuit equation – Model for detection of diabetes – Mixing processes – Non-linear system of equations – Combt models – Predator-prey equation, qualitative theory of differential equation – Interacting species – spread of epidemics, Modeling Linear systems by frequency response methods. **13 hrs**

Modes leading to linear and nonlinear partial differential equations: Simple models, conservation law – Traffic flow on highway – Flood waves in rivers – glacier flow, roll waves and stability, shallow water waves– Convection diffusion – processes Burger's equation, Convection – reaction processes – Fisher's equation. Telegraphers equation, heat transfer in a layered solid, Chromatographic models, sediment transport in rivers **13 Hrs**

Modeling of ground water flow: Porous media-Aquifers-Porosity- Permeability and Averages-Derivations od Darcy and Darcy equations. Basic ground water flow using Darcy model, Dam seepage, Duipuit approximation, Subsurface flow with similarity solutions. **13 hrs**

Air Pollution: Background -origin-Atmospheric composition, sources of air pollution, primary and secondary air pollutants, effects of air pollution, mathematical principles of air pollution using gradient diffusion model, conservation of mass, momentum, and species, turbulent flow in atmosphere, mixture of SPM and atmospheric fluid, dispersion of SPM aerosols.
Modeling in Biomechanics: Fundamental concepts of biomechanics, mathematical modeling of hemolysis, Synovial joints and coronary artery diseases (mainly based on dispersion phenomena). **13 Hrs**

TEXT BOOKS:

1. M.Braun, C.S.Coleman and D.A.Drew, Differential Equation Models,Springer Verlag (1978).
2. LokenathDebnath, Nonlinear partial differential equations, Hillhauser, Boston (1997).

REFERENCE BOOKS:

1. Neil Gerschenfeld: The nature of Mathematical Modeling, Cambridge University Press, 1999
2. A.C. Fowler: Mathematical Models in Applied Sciences, Cambridge University Press, 1997.

M403T L	Flight Dynamics	4 hours/week(52 hours)	4 Credits

Fluid Mechanics of Aircraft

Fluid statics and the atmosphere, Fluid dynamics- Conservation of mass, The momentum theorem, Euler's equation of motion, Bernoullis equation, Determination of free stream velocity, Potential flow-velocity potential and stream function, Calculation of flows for circular cylinders, arbitrary shapes.

13 hours

Cruising Flight Performance

Forces and moments acting on a flight vehicle – Equation of motion of a rigid flight vehicle – Different types of drag –estimation of parasite drag co-efficient by proper area method- Drag polar of vehicles from low speed to high speeds – Variation of thrust, power with velocity and altitudes for air breathing engines. Performance of airplane in level flight – Power available and power required curves. Maximum speed in level flight – Conditions for minimum drag and power required **13 hours**

Manoeuvring Flight Performance:

Steady level flight-Maximum and minimum speed and variations with altitude, Steady climb, angle of climb, absolute and service ceiling. Range and endurance – Brequetformulae; range in constant velocity flight; Effect of wind. Accelerated level flight and climb; Gliding flight (Maximum rate of climb and steepest angle of climb, minimum rate of sink and shallowest angle of glide) -Turning performance (Turning rate turn radius). Bank angle and load factor – limitations on turn – V-n diagram and load factor.

13 hours

Static Longitudinal Stability

Degree of freedom of rigid bodies in space – Static and dynamic stability – Purpose of controls in airplanes -Inherently stable and marginal stable airplanes – Static, Longitudinal stability – Stick fixed stability – Basic equilibrium equation – Stability criterion – Effects of fuselage and nacelle – Influence of CG location Power effects – Stick fixed neutral point – Stick free stability-Hinge moment coefficient – Stick free neutral points-Symmetric manoeuvres – Stick force gradients – Stick _ force per 'g' – Aerodynamic balancing.

13 hours

TEXT BOOKS

1. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley &Son:,Inc, NY, 1988.
2. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 2004.
3. McCornick. W., "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, NY, 1979.

REFERENCES:

1. Etkin, B., "Dynamics of Flight Stability and Control", Edn. 2, John Wiley, NY, 1982.
2. Babister, A.W., "Aircraft Dynamic Stability and Response", Pergamon Press, Oxford, 1980.
3. Dommasch, D.O., Sherby, S.S., and Connolly, T.F., "Aeroplane Aero dynamics", Third Edition, Issac Pitman, London, 1981.
4. Mc Cornick B. W, "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, NY, 1995

M404P	Latex and Latex Beamer	4 hours/week	2 Credits

1. **Using environment, type the following text**

1.Numbering 1
a. Type 1
• bullet 1
• bullet 2
b. Type 2 ○bullettypecircle 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.Alphabeticsa,b,c, d, so on iii.Uppercasealphabetics A,B,C, iv.Include special symbols @,$,%,&, ×,(), {},\, / , #, !
v. Include Mathematical symbols $\Delta,\pi,\varphi,\infty,\mu,\alpha,\eta,\theta,\lambda,\xi,\chi,\tau,\sigma,\beta,\Omega,\Psi,\Upsilon,\vartheta$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.**

BOS CHAIRPERSON
Department of Mathematics
Bengaluru Central University
Central College Campus
Bengaluru - 560 001