DEPARTMENT OF MATHEMATICS

T R I P U R A U N I V E R S I T Y

M.A./M.Sc.
MATHEMATICS
DRAFT SYLLABUS
2008
(SEMESTER SYSTEM)
I-IV

PREAMBLE

From the Academic Session 2008-2009 Tripura University converted the PG course to Semester system. On this circumstance we are to revise our previous syllabus.

There will be 4 Semesters in place of two year course (part-I & II). In the PG course of Mathematics there will be total 1600 marks, each semester will be of 400 marks.

In each Semester there will be 4 papers, each of 100 marks, i.e. there will be total 16 papers in this course, out of which 13 will be compulsory papers and 2 special papers and 1 project paper, special papers to be selected by the students, first special paper will be taught in the 3rd semester and second special paper in the 4th semester. In all these papers except the project paper 20% marks will be allotted for class assessment (i.e., the students have to appear for examination for 80 marks in each of these papers).

The structure of the syllabus of the M.Sc. Mathematics in semester system (I-IV) was placed before the committee. The members discuss the structure and the syllabus in details and finally approved the modified enclosed structure and the syllabus to be effected from 2008-2009 session.

Out of 20 internal mark in each paper, there will be class test of 10 marks and internal assessment of 10 marks will be taken for each paper.

The M.Sc. dissertation (about 100 pages) on a topic from special paper(taken by the candidate) is to be submitted for the project (M403). The candidate has to face a public seminar on his/her dissertation. All the teachers present in the seminar will evaluate overall presentation including viva for 20 marks.

At the end of each semester there will be an examination whose rules and regulation will be followed as directed by the Controller of Examinations of the PG courses of the Tripura University.

Course Structure

Semester –I

Paper-M101 :	Discrete Mathematics	: 80+20=100 Marks
Paper-M102 :	Real Analysis & Lebesgue Measure	: 80+20=100 Marks
Paper-M103 :	Complex Analysis	: 80+20=100 Marks
Paper-M104 :	Integral Transforms & Integral Equations	: 80+20=100 Marks

Semester –II

Paper-M201 :	Algebra	: 80+20=100 Marks
Paper-M202 :	Topology	: 80+20=100 Marks
Paper-M203 :	Operation Research & Optimization Technique	: 80+20=100 Marks
Paper-M204 :	ODE & PDE.	: 80+20=100 Marks

Semester –III

Paper-M301 :	Differential Geometry of Manifolds	: 80+20=100 Marks
Paper-M302 :	Mechanics	: 80+20=100 Marks
Paper-M303 :	Numerical Methods and Computer Programming	: 80+20=100 Marks

Special Paper

Students of Semester-III have to opt any one of the following :

Paper-M304 :	Fuzzy Set Theory	: 80+20=100 Marks
Paper-M305 :	Advanced Topology-I	: 80+20=100 Marks
Paper-M306 :	Algebraic Topology	: 80+20=100 Marks
Paper-M307 :	Mechanics of Solids-I	: 80+20=100 Marks
Paper-M308 :	Probability & Measure	: 80+20=100 Marks

Semester –IV

Paper-M401 :	Functional Analysis	: 80+20=100 Marks
Paper-M402 :	Computer Programming and Numerical Methods ---Practical	: 80+20=100 Marks
Paper-M403 :	Project	: 100 Marks

Special Paper

Students of Semester-IV have to opt any one of the following :

		Prerequisite	
Paper-M404 :	Fuzzy Logic, Rough Sets & Applications	M304	: 80+20=100 Marks
Paper-M405 :	Fuzzy Set Topology	M304	: 80+20=100 Marks
Paper-M406 :	Advanced Topology-II	M305	: 80+20=100 Marks
Paper-M407 :	Differential Topology	M306	: 80+20=100 Marks
Paper-M408 :	Topology of Fibre Bundles	M306	: 80+20=100 Marks
Paper-M409 :	Mechanics of Solids-II	M307	: 80+20=100 Marks
Paper-M410 :	Stochastic Process	M308	: 80+20=100 Marks
		Total	**1600 Marks**

SEMESTER-I

Paper-M101

DISCRETE MATHEMATICS

Full marks- 80+20=100

Unit – I (Marks-40)

1. **Formal logic-1 :** Statements, truth value and truth table, logical connectives, logical equivalence, tautologies and contradictions, arguments, propositional logic, applications of propositional logic to everyday reasoning.
2. **Formal logic-2:** Proofs, introduction to predicate calculus, quantifiers, applications of predicate logic to everyday reasoning.
3. **Lattices:** Partial order relations, lattices - definitions, examples, properties of lattices, properties of complete lattice, bounded lattice, complemented lattice and distributive lattices

4. **Boolean algebras :** Boolean algebras - Boolean subalgebra, basic properties Boolean homomorphism , Boolean algebra as lattices, Boolean expressions and Boolean functions, sum of product, product of sum, minterm, maxterm, minimization of Boolean functions, Karnaugh map method.

Unit – II (Marks-40)

5. & 6. **Graph theory** : Basic concepts, definitions and examples, degree of vertex, sub graphs, complete graph, connected graph, walk, path, cycles, matrix representation of graph, adjacency matrix, incidence matrix, path matrix, Warshall's algorithm, planar graph, Eulerian path, tournament and Hamiltonian path. Directed graphs, in degree and out degree of a vertex, weighted undirected graphs, Dijkstra's algorithm, trees, binary trees, spanning trees, minimal spanning trees, Kruskal's algorithm.

7. **Grammar, languages and automata :** Vocabulary, word, grammar and language, finite state machines, finite state automata, state table, transition diagrams.
8. **Automata and Turing Machines :** Deterministic FSA , non-deterministic FSA, automata as language recognizers, Turing machines.

References :

1. C.T.Liu , Elements of Discrete Mathematics, Tata Mcgraw-Hill Pub. Co. ltd. , 2000
2. J. P. Tremblay & R. Manohar, Discrete Mathematical Structures with Appl. to Computer Science, McGraw – Hill Book Co., 1977.
3. J. Truss,Discrete Mathematics for Computer Scientists,Pearson Education,3rd edn,2002
4. R. Johnsonbaugh, Discrete Mathematics, Pearson Education Asia, 5th edn.,2003
5. T. Veerarajan , Discrete Mathematics with Graph Theory and Combinatorics, Tata McGraw – Hill Pub. Co. ltd,2007

Paper – M102
REAL ANALYSIS
& LEBESGUE MEASURE

Full Marks-80+20=100

Unit-I (Marks-40)

1. **Metric Space :** Revision of Metric space, Cantor intersection Theorem, completion of incomplete metric space, Baire category theorem, separability, equivalent matrices, continuous function, extension theorem, uniform continuity.
2. **Functions on R** : Function of bounded variation and its connection with monotone functions.
3. **Riemann-Stieltje's integral** : Definition and example of Riemann-Stieltje's integral, properties of the integral, Integration and differentiation, Concept of zero Lebesgue measure and their basic theorems, Lebesgue criterion of Riemann integrability
4. **Fourier Series**: Cesaro summability, L^2-space, convergence and completeness in the space, Trigonometric Fourier series, $L[-\pi,\pi]$ space and Fourier series for functions in $L[-\pi,\pi]$. Convergence at a point and over an integral, Fejer's theorem, Riemann Lebesgue theorem, Bessel's inequality and Parseval's theorem.

Unit-II (Marks-40)

5. **Lebesgue measure on subsets of R** : Lebesgue inner and outer measure and Lebesguemesure of bounded subset of **R,** Lebesgue outer measure of unbounded subset of **R** , Lebesgue measurable set, their structural specialties, non-measurable set. Borel sets in **R**.
6. **Measurable functions**: Lebesgue measurable function, almost everywhere property , sequence of measurable functions, almost everywhere convergence and almost uniformly convergence, Egorov theorem, Lusin's theorem.
7. & 8. **Lebesgue Integration** : Simple function, Lebesgue integration of simple function ,Lebesgue integration of bounded function, Lebesgue integration of non negative measurable function, monotone convergence theorem, Fatou's lemma, Lebesgue integrable function, dominated convergence theorem, Riemann integrability and Lebesgue integrability.

References:

1. W.Rudin, Principles of Mathematical Analysis, McGrawHill,1976
2. T.M.Apostal, Mathematical Analysis, Narosa Pub. House, 1985
3. A.Gupta, Real and Abstract analysis, Academic Publications.
4. H.L.Royden, Real Analysis, Prentice Hall of India
5. White & Stromberg, Real and Abstract Analysis, Springer-Verlag

Paper – M103
COMPLEX ANALYSIS
Full Marks-80+20=100

Unit-I (Marks-40)

1. Complex integration: Cauchy-Goursat theorem, Cauchy integral formula, Cauchy integral formula for higher derivatives, Moreras theorem, Cauchy inequality, Liouville's theorem, the fundamental theorem of algebra.
2. Sequence and series of functions, power series, Taylor theorem, zeros of an analytic function, Schwarz lemma, Isolated singularity .
3. Laurent's theorem, classification of isolated singularities: pole, essential singularity , removable singularity , residues Casorati-Weierstrass theorem.
4. Meromorphic function, Rouche's theorem, Inverse function theorem, inverse function theorem, open mapping theorem, Cauchy residue theorem.

Unit-II (Marks-40)

5. Contour integration, Maximum module theorem, convex function, Hadamard three circle theorem.
6. Many-valued function, Branches of many-valued function, branch points. Conformal transformation, Bilinear transformation, cross ratio.
7. Infinite product, Weierstrass factorization theorem, factorization of some well known functions, the Gamma function, Riemann Zeta function. Analytic continuation: Direct method of analytic continuation, Schwarz reflection theorem, analytic continuation along a path, power series method of analytic continuation, Monodromy theorem.
8. Harmonic function: Harmonic function on a disk , Harnack' inequality, Harnack' theorem, Poisson integration formula. Entire function: Jensen's formula, Poisson-Jensen formula, the genus and order of an entire function, Hadamard factorization theorem.

References:

1. J.B.Conway ,Functions of a one complex variable, Narosa publishing house,1973
2. W.Rudun, Real and Complex Analysis, McGrawHill
3. H.S.Kasana, Complex Variable, Prentice Hall of India,2005
4. S.Punnusamy, Foundations of Complex Analysis, Narosa publishing house,2005
5. L.V.Ahlfors, Complex Analysis, McGrawHill,1979
6. Churchill,Complex Variables and Applications, McGrawHill

Paper – M104

INTEGRAL TRANSFORMS
& INTEGRAL EQUATIONS
Full Marks-80+20=100

Unit-I (Integral Transforms) (Marks-40)

1. Fourier transforms, Fourier cosine transforms, Fourier sine transforms, Fourier transforms of derivative, Parseval's theorem for cosine and sine transforms. Multiple Fourier transforms, inversion theorem for Fourier transform, inverse Fourier sine transform, inverse, inverse Fourier cosine transform, inverse , Inverse Fourier complex transformation, the convolution theorem, relationship between Fourier and Laplace transforms.
2. Applications of Fourier transforms, solution of integral equation.. Complex inversion formula for Laplace transform, solution boundary value problems by Laplace and Fourier transforms.
3. Mellin transforms, elementary properties, Melline transforms of derivative and integral, Melline inversion theorem, convolution theorem. Applications of Mellin transforms,summation of series
4. Hankel transforms, elementary properties of Hankel transforms, the Hankel inversion theorem, Hankel transforms of derivatives of functions, Hankel ransformation of elementary functions, Parseval's relation for Hankel transforms, relation between Fourier and Hankel transforms . Applications of Hankel transforms , solution of partial differential equation.

References:

1. I.N.Sneddon, The Use of Integral Transforms, Tata McGrawHill
2. B.P.Parasar, Differential equation and integral equation, SBS Publications

Unit-II (Integral Equations) (Marks-40)

5. Integral Equation: Definition, different types of integral equations; kernels; eigen value and eigen function problem. Conversion of ordinary differential equations into integral equations; Green's function and its applications.
6. Fredholm integral equation of the second kind with separable kernels. Solution of Fredholm and Voltera integral equations by successive approximation.
7. Classical Fredholm theory: Statements of Fredholm's first , second and third fundamental theorem and their applications. Integral equations with symmetric kernels.
8. Singular integral equations. Integral transform method of solution of integral equations.

References:

1. B.P.Parasar, Differential equation and integral equation, SBS Publications
3. Petrovsky, Integral Equation, Mir Publication
4. G.Yankovsky, Problems and exercise in Integral Equation, Mir Publication
5. R.R.Goldberg, Fourier Transform, Cambridge Univ. Press.

SEMESTER-II

Paper – M201

ABSTRACT ALGEBRA

Full Marks-80+20=100

Unit-I (Marks-40)

1. **Group Theory**: External direct product of groups, direct product of cyclic groups.
2. **Group action**: Extended Cayley's theorem, Conjugacy classes, class equation, Cauchy theorem.
3. **p-groups** : Sylow's theorems, Simple groups, determination of all simple groups of order $\leq$ 60.
4. **Normal and Subnormal series**: Composition series, Jordan-Holder theorem, Solvable groups, Nilpotent groups. **Modules**: R-Modules, sub-modules,Module-homomorphism, Cyclic modules, simple modules.

Unit-II (Marks-40)

5. **Ring theory**: Boolean ring, characterization of Boolean ring. Principle ideal domain, Euclidean domain. Prime elements, irreducible elements, unique factorization domain.
6. Maximal ideal, prime ideal and primary ideal. Northerian, Artinian and polynomial rings. Factorization of polynomial over a commutating ring with identity.
7. & 8. **Field theory**: Extension fields, algebraic and transcendental extension , separable and normal extensions. Finite fields, perfect fields, primitive elements, algebraically closed fields.Automorphisms of extentions. Galois extention, fundamental theorem of Galois theory. Solution of polinomial equation by radicals, Insolvability of general equation of degree 5 by radicals.

References:

1. D.S.Malik, J.N.Mordeson & M.K.Sen, Foundations of Abstract Algebra, McGrawHill.
2. M.K.Sen, S.Ghosh, P. Mukhopadhyay,Topics in Abstract Algebra, University Press
3. I.N.Herstein, Topics in Algebra, John Willy
4. P.B.Bhattacharya, S.K.Jain, & S.R.Nagpal, Basic Abstract Algebra, Cambridge Publcations

TOPOLOGY

Full Marks – 80+20=100

UNIT- I (Marks-40)

1. Topological spaces- definition and examples, Neighbourhoods, Closed sets , dense subsets, Closures, Interiors, exteriors, boundary, accumulation points and derived sets, Bases and sub-bases,
2. Nets and filters, convergence of nets and filters , ultra filters, Continuous functions, homeomorphisms,

Construction of topologies: Subspace topology, product topology and projection maps, quotient topology.

3. Separation Axioms- T_0, T_1, T_2 , T_3, $T_{3.5}$, T_4 – spaces, their characterizations, basic properties, Examples and counter-examples, Urysohn Lemma, Tietze extension theorem
4. Connected spaces , examples and properties , components, connectedness on the real line, Locally connected spaces.

UNIT-II (Marks-40)

5. First and second countable spaces, examples and properties, separable space and Lindeloff spaces – examples and properties,
6. Compact spaces - Examples, compactness and finite intersection property, basic properties of compactness, Countably compact spaces, sequentially compact spaces.
7. Metrizable Space- Definitions and examples, properties, subspaces, product of metrizable spaces, Metrization theorems- Urysohn‘s metrization theorem, Nagata-Smirnov metrization theorem.
8. Function Space- Pointwise convergence, uniform convergence, the compact-open topology, equi-continuity, mutual relationships, Ascoli’s theorem.

References :

1. B.C.Chatterjee,S.Ganguly & M. Adhikary, A Text Book of Topology, Asian Books
2. J.L.Kelly, General Topology, Von Nostradon,1966
3. J.R.Munkres, Topology,A first Course
4. K.D.Joshi, Int. to General Topology, Weyley Eastern
5. S.W.Davis, Topology , Tata McGraw Hill
6. S. Willard, General Topology, Addiotson –Wesley

Paper – M203

OPERATION RESEARCH

& OPTIMIZATION TECHNIQUES

Full Marks-80+20=100

UNIT-I(Operation Research) (Marks-40)

1. Operation Research and its scope, Necessity of operation research, Revised Simplex method, Decomposition principle
2. Parametric linear programming, Upper bound technique, linear goal programming , multi objective linear programming
3. Sensitivity analysis, Transshipment problem, shortest path problem, minimum spanning tree
4. Network analysis, minimum cost problem, maximum cost problem

Unit-II(Optimization Techniques) (Marks-40)

5. & 6. Nonlinear Programming : Convex and non convex programming, Kuhn Tucker conditions for constrained optimization, Quadratic programming

7. Separable programming, Dynamic programming: Deterministic and probabilistic dynamic programming

8. Integer programming: Branch and Bound technique, Gomorys cutting plane method.

References:

1. F.S.Hiller & G.C.Leiberman, Int. to Operation Research, McGraw-Hill,1995
2. G.Hadly, Nonlinear and Dynamic Programming, Addison Wesley.
3. Kanri Swarup, P.K.Gupta & Man Mohan, Macmillan.
4. K.P.P.Chong, Stanislaw H.Zak, An Int. to Optimization, John Welly & Sons, 2001

Paper – M204
ORDINARY DIFFERENTIAL EQUARIONS & PARTIAL DIFFERENTIAL EQUATIONS

Full Marks-80+20=100

Unit-I(Ordinary Differential Equarions) (Marks-40)

1. **Fist order ordinary differential equation:** Singular solution, initial value problem of first order ODE, general theory of homogeneous and non homogeneous linear ODE, Basic theorems, Ascoli-Arzoli theorem, theorem on convergence of solution of initial value problem, Picard-Lindeloff theorem, Piano's existence theorem and corollaries.
2. Independence of the solution of linear differential equation, Wronskian and its properties, exact differential equation and equation of special form.
3. & 4. **Linear differential equation of second order:** Series solution by the metho of Frobenius; Hypergeometric equation and Hypergeometric functions, Legendre differential equation and Legendre polynomials, Bessel's differential equation and Bessel's function. Laguerre differential equation and Lagurre polynomial, Hermite differential equation and Hermite polynomial; recurrence relations, orthogonal properties, investigation of simple properties.

Reference:

1. Codington and Levison, Theory of Ordinary Differential equations, Tata McGrawHill
2. Estham, Ordinary Differential equations
3. Hertman, Ordinary Differential equations, John Wiley
4. W.T.Reid, Ordinary Differential equations
5. J.C.Burkill, Ordinary Differential equations

Unit-II(Partial Differential Equations) (Marks-40)

5. **Partial Differential equation of first order & Transportation** : examples of partial differential equation , classification . initial value problem , Non Homogeneous equation
6. **Laplaces equation** : Fundamental solution , Mean value formula , properties of solutions , energy method.
7. **Heat equation** : fundamental solution , Mean Value formula , energy methods
8. **Wave equation** : Solution by spherical means , non homogeneous equation , Energy method.

References :

1. Sneddon: Partial Differential equation , Mc Graw Hill
2. MG Smith: Partial Differential equation
3. Pinsling : Intr to Partial Differential

SEMESTER-III

Paper – M301

DIFFERENTIAL GEOMETRY OF MANIFOLDS

Full Marks-80+20=100

Unit-I (Marks-40)

1. & 2. **Differentiable manifold** : Some calculus on $\mathbf{R}^n$ - Continuity and differentiability of function from $\mathbf{R}^n$ to $\mathbf{R}^m$, Inverse function theorem, Implicit function theorem, the existence and uniqueness theorem of solution of ODE. Smooth manifold, Examples of Differentiable manifold, Smooth maps between two manifolds, diffeomorphism, Tangent space, Derivative of a smooth map between two manifolds, Tangent bundle. Bump function , partition of unity and its applications in extending a differentiable function. **Immersion , submersion , embedding , submanifold** : Definitions and examples, regular and critical point, Whitney weak embedding theorem , statement of Whitney embedding theorem and its consequences .

3 **Vector field**: Lie bracket, integral curve of a vector field, flows and local flows, existence of integral curve,complete vector field,existence of complete vector field,vector fields related by a differentiable map. **Distribution**: Involutive distribution, the Frobenious theorem and its applications.

3. **Lie group and Lie algebra**: Left invariant vector fields, exponential map and its applications, Lie algebra homomorphism, one parameter subgroups, Adjoint representation.

Unit-II (Marks-40)

4. **Tensor analysis**: Multilinear algebra, exterior algebra, tensor fields, differential forms, exterior differentiation, Lie derivative.
5. **Riemannian Manifold**: Riemannian metric, existence of Riemannian metric, linear connection , existence of linear connection, torsion and curvature of a linear connection, symmetric connection, symmetric connection, metric connection, Riemannian connection, existence of Riemannian connection. Riemann curvature, sectional curvature, Ricci tensor, scalar curvature, tensors in Riemannian manifold, Schur's theorem.
6. & 8. **Parallel vector field, Geodesics**: Existence of geodesic, parallel translation, length minimizing property of geodesic. complete manifold, Hopf-Rinow theorem, Hadamard theorem. Parametrised surface, Gause lemma. Totally geogesic submanifold. **Isometric immersion**: Riemannian submanifold , second fundamental form of a Riemannian submanifold, Gauss equation, Ricci equation, Coddazi equation.

References:

1. S.Kumeresan, A Course in Differential Geometry and Lie Groups,Hindusthan Book Agencies,New Delhi,2002
2. U.C.De and A.A.Shaikh , Differential Geometry of Manifolds,Narosa Publishing House,2007
3. S.Boothby, An Introduction to Differentiable Manifolds and Riemannian Geometry, Accademic Press,1975
4. F.W.Warner, Foundations of Differentiadle Manifolds and Lie Groups, Springer Verlag,1983

Paper – M302
MECHANICS
Full Marks-80+20=100

Unit-I(Classical Mechanics) (Marks-40)

1. Generalized co-ordinates, holonomic and non holonomic systems, unilateral and bilateral constraints; principle of virtual work, D'Alemberts principle. Variational principle, problems of mechanics, moving problems of calculus of variations, shortest distance, minimum surface of revolution, Brachistochrone problem iso-perimetric problem, geodesic, fundamental lemma of calculus of variations.
2. Lagranges equation of first kind and of second kind, uniqueness of solution, energy equation of conservation fields, generalized momentum, problem of Liouville type, cyclic co-ordinates.
3. Hamilton's principle, principle of least action, Routh's equation, Hamilton-canonical equation of motion, Poisson bracket, Poisson's identity, Jacobi-Pisson theorem.
4. Pontryagon's principle (statement only), application of Bang-bang control, flight trajectory. Optimization, simple models of optimal economic growth.

References:

1. D.N.Berghese and A.m.Pouss, Classical mechanics and Control, John Willey
2. Goldstein, Classical Mechanics, Narosa Publications
3. Rana and Jong, Classical Mechanics, Narosa Publications
4. E.T.Whittecker, Treatise on the Analytical Dynamics and Rigid Bodies.

Unit-II(Fluid Mechanics) (Marks-40)

5. **Kinematics of fluid flow**: Description of fluid motion, Lagrangian and Euler method, relation between these methods. Definition of steady and unsteady flows, uniform and non-uniform flows , one dimensional and two dimensional flows. Three dimensional, axi-symmetric flows, line of flow, streamline, pathline, stream surface, stream tube, streakline. Velocity of a fluid particle at a point. Local, conservative and material derivatives. Equation of continuity.
6. **Hydrodynamics**: Inviscid incompressible fluid, field equations, Bernaulli theorem and applications. Cauchy integral, Helmholtz's equation, impulsive generation of motion, Kelvin's circulation theorem of minimum K.E.
7. **Two and Three dimensional Motion**: Three dimensional motion, image of a source, sink and doublet w.r.t. a plane and sphere.Sphere theorem, D'Alembert's paradox, two dimensional motion, Stoke's stream function, complex potential, circle theorem, Blassius theorem, Kutta-Jonkowski theorem.
8. **Viscous flow**: Navier Stoke's theorem, vorticity, image of a vortex w.r.t. a circle. A single infinite row of vertices, Karman's vortex sheet, vortex pair and doublets, flow between parallel plates, flow through pipes of circular , annular , rectangular, elliptic and triangular sections.

References:

1. WH.Besaint and A.S.Ramsey, A Tretise on Hydrodynamics,Pt-II,CBS Publishers, Delhi, 1988
2. G.K.Batchelor, An Int. to Fluid Mechanics, Foundation Books, New Delhi, 1994
3. F.Charlton, Textbook of Fluid Dynamics, CBS Publishers, Delhi, 1985
4. A.J.Choinand A.Morsden, A Mathematical Int, to Fluid Dynamics, Springer Verlag,1993
5. L.D.Landau and E.M.Lipschitz, Fluid Mechanics, Pergamon Press, London, 1985

Paper – M303
NUMERICAL METHODS
& COMPUTER PROGRAMMING

Full Marks-80+20=100

Unit-I(Numerical Methods) (Marks-40)

1. Computer number system, instability and pitfalls of computation. **Solutions of non linear algebraic equations**: Roots of Polynomial equations: Sensitivity of Polynomial Roots , Steffensen method, Bairstows method of quadratic factors, Graeffes root squaring method
2. **Matrices and eigen value problem** : LU decomposition of matrices, Power method of extreme eigen values , Jacobis method for symmetric matrices.
3. **Solution of system of linear equation**: Triangular factorization , relaxation method. **Interpolation**: Hermite interpolation , Spline interpolation – cubic splines , least square approximation to discrete data. **Approximation of function** : Chebyshev approximation , Lanczos economisation, least square approximation and orthogonal polynomials**.**
4. **Integration**: Gaussian Legendre and Gaussain Chebyshevs quadrature , Richardson extrapolation, Euler Maclaurins sum formula, Rombergs integration. **Differential equations**: First order equation : existence , uniqueness , stability of solution Eulers method, Multi step predictor corrector method , Runge Kutta method. **Partial differential equation** : Hyperbolic equation by the method of characteristic , Simple parabolic equation by explicit finite difference methods.

References :

1. Ralston A , Sa first course in Numerical Analysis, Mc Graw Hill , N. Y(1965)
2. Conte SD , Boor, C de, Elementary numerical analysis (An algorithmic approach) MC GrawHill, Kogakusho. Ltd
3. Hildebrand, F. B. Introduction to Numerical Analysis, Mc GrawHill N. Y
4. Ames W. F. Numerical methods for Partial Differential equations , Academic press N. Y 1977

Unit-II(Computer Programming) (Marks-40)

A. Programming in C :

5. Review of basic concepts of C-programming. Further Data Types :Structures ,Defining New Data Types ,Unions ,Coercion or Type-Casting ,types, Static. Pointers :What is a Pointer? ,Pointer and Functions ,Pointers and Arrays ,Arrays of

Pointers ,Multidimensional ,arrays and pointers ,Static Initialization of Pointer Arrays ,Pointers and Structures ,Common Pointer Pitfalls , exercise

6. The C Preprocessor :#define ,#undef ,#include ,#if -- Conditional inclusion , Preprocessor Compiler Control ,Other Preprocessor Commands. Input and Output (I/O):stdio.h ,Reporting Errors ,perror() ,errno ,exit() ,Streams ,Predefined Streams ,Redirection ,Basic I/O ,Formatted I/O ,Printf ,scanf ,Files ,Reading and writing files ,sprintf and sscanf ,Stream ,status Enquiries ,Low Level I/O ,Exercises

B MATLAB 7 :

7. **Basic Features** : Simple Math, The Matlab workspace, About variables, complex number, floating point arithmetic, Mathematical functions. **Script M files** : Use, Block comments and code cells, startup and finish. **Array and Array operations**: Simple array, Array addressing or indexing, Array construction, Array orientation, scalar Array Mathematics, array Manipulation, Array sorting, Sub array searching, Array size, Array and Memory utilization, Multidimensional Array construction & its manipulation. **Numeric data type**: Integer data type, floating point data types
8. **Cell Arrays and structures**: Cell array creation, its manipulation , Retrieving cell array content, comma separated list, cell functions, cell array of strings, structure creation, structure manipulation, structure functions. **Character string**: String construction, string evaluation, string functions, cell array of strings. **Relational and logical operations**: Relational and logical operators, Relational and logical functions, Nans and empty, operator precedence. **Control flow**: For loops, while loops, if else end construction, switch case construction, Try catch blocks

References:

1. Peter A Darnell and P E Margolis, C : A software Engineering approach, Narosa publishing House (Springer International student Edition), 1993
2. S. P. Harkison and G.L Steel ; A Reference manual , 2nd edition , Prentice Hall, 1984
3. A. K. Mukherjee & A. K. Das , data structure, C, C++
4. Mastering MATLAB 7: Duane Hnselman, Bruce Littlefeild
5. Introduction to MATLAB 7 for Engineers (Paperback): William J Palm III (Author), William Palm.

Paper – M304
FUZZY SET THEORY
Full Marks-80+20=100

Unit-I (Marks-40)

1. **Fuzzy sets-1**: Characteristics function and definition of fuzzy sets, fuzzy point, α -level sets, convex fuzzy sets, basic operations on fuzzy sets.
2. **Fuzzy sets-2**:Cartesian products, algebraic products, bounded sum and difference, t-norms and t-co norms, quasi-coincidence of two fuzzy subsets.
3. **Generalization and variants of fuzzy sets** : L-fuzzy sets, interval-valued fuzzy sets, Type 2 fuzzy sets, intuitionistic fuzzy sets and set operation of intuitionistic fuzzy sets,The Zadeh's extension principle.
4. **Fuzzy arithmetic**: Fuzzy numbers, triangular fuzzy numbers, Fuzzy numbers describing 'Large' , Fuzzy numbers in the set of integers, Arithmetic operation on intervals and fuzzy numbers.

Unit-II (Marks-40)

5. **Fuzzy relations and fuzzy graphs** : Fuzzy relations on fuzzy sets, composition of fuzzy relations, Max-Min and Min-Max compositions, basic properties of fuzzy relations,
6. **Fuzzy order :**Fuzzy pre order and fuzzy order relations, fuzzy equivalence relation, fuzzy compatibility relations, fuzzy graphs, fuzzy similarity relations, examples of different fuzzy relations, fuzzy relation equations based on sup-i and inf-ω_i compositions.
7. **Fuzzy functions,** Fuzzy functions on fuzzy sets, image and inverse image of fuzzy sets and some basic theorem on fuzzy functions.
8. **Fuzzy matrix** : Sum , multiplication of two fuzzy matrices, Idempotent fuzzy matrix and their problems.

References:

1. H.J.Zimmermann, Fuzzy Set Theory and its Applications , Allied Publishers Ltd.1991
2. G.J.Klir and B.Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India, 1995
3. G.Bojadziev and M.Bojadziev, Fuzzy Sets, Fuzzy Logic, Applications, World Sci,1995

Paper – M305
ADVANCED TOPOLOGY-I
Full Marks-70+20=100

Unit-I (Marks-40)

1. **Uniform Spaces** : Uniformities, diagonal uniformities, uniform- covers-uniform topology, uniform continuous map, uniformizability and uniform metrizability, complete uniform spaces, totally bounded uniform spaces.
2. **Proximity Spaces :** Proximity relation, definition and examples of proximity spaces, Topology induced by a proximity, alternate description of proximity spaces (δ-nbd), subspace, product of proximity spaces, clusters and ultra-filters in proximity space, compactness and proximities.
3. **Extemally Disconnected and Zero-dimensional Space** : Clopen sets, zero-dimensional space, strongly zero-dimensional spaces, characterizations of extremally disconnected spaces.

Unit-II (Marks-40)

1. **Category Theory :** Definitions and examples, functors and natural transformations, covariant and contravariant functors, topological categories, morphisms, sub-categories-reflective, epi-reflective and coreflectives sub-categories.
2. **Int. to Algebraic Topology :** Homotopy of paths, contractible space, The fundamental group, covering spaces, The fundamental group of the circle.

References:

1. S.Willard, General Topology, Wesley.
2. R.Engelking:Outline of General Topology,North Holland.
3. J.L.Kelley: General topology, D.Von-Nostrand.
4. J.R.Porter & R,G.Woods: Extensions and Absolutes of Housdorff Spaces, Springer Verlag.
5. Naimpally & Warrack :Proximity Spaces, Cambridge University Press.

Paper – M306
ALGEBRAIC TOPOLOGY
Full Marks-80+20=100

Unit-I (Marks-40)

1. **Category and Functors** : Definitions and examples, functors and natural transformations, covariant and contravariant functors, topological categories, morphisms, sub-categories.
2. **The Fundamental group**: Homotopy , contractible spaces and homotopy type, fundamental group and its properties, simply connected spaces, the fundamental groups of circle.
3. **Finite Simplicial Complexes** : Simplicial complexes, polyhedra and triangulations, simplicial approximation, barycentric subdivision.
4. **Simplicial Homology-1** : Orientation of simplicial complexes, simplicial chain complexes and homology. Properties of integral homology groups.

Unit-II (Marks-40)

5. **Simplicial Homology-1** : Induced homomorphisms, degree of map, invariance of homology groups.

6. **Covering Projections** : Properties, applications to homotopy lifting theorem, lifting of arbitrary Map, covering homorphisms, universal covering space.

7. & 8**. Singular Homology-1** : Singular chain complex, one-dimensional homology and fundamental groups, homotopy axiom for singular homology, relative homology and the axioms, the axcision theorem, homology and cohomology theories, singular homology with co-efficients, Mayer-Vietoris sequence, singular cohomology and cohomology algebra. Chain complexes and homology, tensor product of two chain complexes, exact homology sequence theorem.

References:

1. S.De,Algebraic Topology, Hindusthan Book Agency,(2003)
2. G.E.Bredon ,Topology & Geometry, Springer(1993)
3. J.M.Lee, Int. to Topological Manifolds, Springer(2000)
4. J.R.Munkress,Toplogy,Prentice Hall of India(2003)
5. J.W.Vick,Homology theory an Int. to Algebraic Topology, Springer Verlag(1994)
6. J.J.Rotman.An Int. to Algebraic Topology, Springer(1988)
7. Hatcher, Algebraic Topology, Cambridge University Press

Paper – M307
MECHANICS OF SOLIDS -I
Full Marks-80+20=100

Unit-I (Marks-40)

1&2. **Analysis of strain**: Affine transformation, infinitesimal affine transformation. A geometrical interpretation of components of strain. Strain quadric of Cauchy. Transformation of strain component by changing the co-ordinate system. Principle strains, invariants, general infinitesimal deformation, compatibility equations, linear strain. Examples of strain. Finite deformation.

3&4. **Analysis of stress**: Body and surface force, specification pf stress at a point, equation of equilibrium, symmetry of stress tensor, boundary conditions, transformation of stress components from an co-ordinate to another and stress invariants. Stress quadric. Mohr's diagram, mean stress , stress ellipsoid. Octahedral, normal and shearing stresses. Purely normal stress. Examples of stress. Different formulae.

Unit-II (marks-40)

5&6. **Equations of Elasticity**: Generalized Hook's law, homogeneous isotropic media, elastic moduli for isotropic media, equilibrium and dynamic equations for an isotropic elastic solid, strain energy function and its conservation with Hook's law, uniqueness of solution, Beltrami-Michell compatibility equation, Sain-Venart's principle.

7&8. **Torsion**: Torsion of cylindrical bars, torsional rigidity, torsion and strain functions, line of shearing stress, simple problems related to circle, ellipse and equilateral triangle.

References:

1. I.S. Sokolnikoff,Mathematical theory of Elasticity, Tata McGrawHill, 1977
2. A.E.Love, A Treatise on the Mathematical Theory of Elasticity, Cambridge University Press,1963
3. Y.C.Fung, Foundations of Solid Mechanics, Prentice Hall, 1965
4. S.Timoshenko and N.Goodier, Theory of Elasticity, McGraw Hill, 1975
5. I.H.Dsames, Int. to Solid Mechanics, Prentice Hall, 1975
6. S.Valliappan, Continuum Mechanics, Oxford and IBH Publishing Co. 1981

Paper – M308
PROBABILITY & MEASURE
Full Marks-80+20=100

Unit-I (Marks-40)

1. **Classes of Sets, Measure and Probability Space**: Algebra and sigma algebras, measurable spaces ,product spaces. Measurable transformations. Additive set functions, measure and probability spaces. Induced measure and distribution function. **Binomial**

Random Variable: Poisson theorem, interchangeable events and their limiting probabilities. Bernoulli , Borel theorems. Central limit theorem for binomial random variables, large deviations.

2. **Independence**: Independence, random allocation of balls into cells. Borel-Cantalli theorem, characterization of independence, Kolmogorov zero-onr law. Convergence in probability, almost certain convergence and their equivalence for sums of independent random variables. Bernoulli trials.
3. **Integration in Probability Space**: Definition, properties of integral, monotone convergence theorem. Indefinite integrals, uniform integrability, mean convergence. Jensen, Holders, Schwarz inequality.
4. **Sums of Independent Random Variables**: Three series theorem. Law of large numbers. Stoping times, copirs of stoping times, Wald's equation. Chung-Fuchs theorem, elementary renewal theorem, optimal stoping.

Unit-II (Marks-40)

5. **Measure Extensions, Lebesgue-Stieljes measure Kolmogorov Consistency theorem**: Measure extensions, Lebesgue-Stieljes measure. Integration in measure space. Product measure, Fubini's theorem, n-dimensional Lebesgue-Stieljes measure. Infinite dimensional product measure space, Kolmogorov consistency theorem. Absolute continuity of measures, distribution functions; Radon-Nikodym theorem.
6. **Conditional Expectation, Conditional Independence, Introducing to Martingales**: Conditional Rxpectations, Conditional probabilities, conditional probability measures. Conditional independence, interchangeable random variables. Introduction to martingales.
7. **Distribution Functions and Characteristic Functions** : Convergence of distribution functions, uniform intrgrability, Helly_Bray theorem. Weak compactness, Frechet-Shohat, Glivenko-Cantalli theorems. Characteristic functions, inversion formula, Levy continuity theorem. The nature of characteristic functions, analytic characteristic functions, Cramer-Levy theorem.
8. **Central limit theorem** : Independent components. Interchangeable components. The martingale case. Miscellaneous central limit theorems.

Limit Theorems for Independent Random Variables: Law of large numbers. Law of iterated logarithm.

References:

1. Y.S.Chow & H.Teicher, Probability Theory, Springer(2005).
2. K.R.Prthasarathy, Introduction to Probability and Measure, Hindusthan Book Agencies,New Delhi,2007
3. Kai Lai Chung: A Course in Probability Theory, Elsevier,2005
4. R,B.Ash & C.A.Doleans-Dade: Probability and measure theory, Elsevier,2000

SEMESTER-IV

Paper – M401
FUNCTIONAL ANALYSIS
Full Marks-80+20=100

Unit-I (Marks-40)

1. Normed linear Space, Banach space and examples, Quotient space of normed linear space and its completeness.
2. Equivalent norms, Riesz lemma, basic properties of finite dimensional normed linear space and compactness.

3. Weak convergence and bounded linear transformations, normed linear space of bounded linear transformations, Dual space with examples. Reflexive space.
4. Uniform boundedness theorem and some of its consequence, open mapping and closed graph theorem, Hahn-Banach theorem for real linear space.

Unit-II (Marks-40)

5. Weak sequential compactness, compact operators, solvability of linear equations in Banach space, the closed range theorem.
6. Inner product space, Hilbert space, Orthonormal sets, Bessel's inequality, complete orthonormal sets and Perseval's identity.
7. Structure of Hilbert space, projection theorem, Riesz representation theorem, adjoint of an operator on a Hilbert space, reflexivity of Hilbert space.
8. Self-adjoint operators positive, projection, normal and unitary operators.

References:

1. P.K.Jain, O.P.Ahuja, & K.Ahmed, Functional Analysis, New Age Publications,2004
2. B.K.Lahiri, Elements of Functional Analysis, The World Press Pvt. Ltd.
3. A.H.Siddiqui, Functional Analysis with Applications, Anamaya publications
4. E.Kreyszing, Introductory Functional Analysis with Applications, John Wiley & Sons,1978
5. B.V.Limay, Functional Analysis, New Age Publications
6. G.F.Simmons, Introduction to Topology and Modern Analysis, TataMcGrawHill.
7. J.B.Conway, A Course in Functional Analysis,Springer,2008

Paper – M402
PRACTICAL-COMPUTER PROGRAMMING & NUMERICAL METHODS

Full Marks-80+20=100

The practical examination in computer programming and Numerical methods shall consist of two parts

A. Sessional Work: 25 **B.** Practical Examination: 75 Marks

Practical Examination Consist of Two parts

1. C – Programming: The following topics may be covered

1.Bairstows method	2. Graffes Root squaring method
3. Power Method	4. L.U.Decomposition Method
5. Romberg Method	6. Muller Method
7. Adams Moulton Method	8. Newtons Method
9. Steffensens Method	10. Least square method
11. Gauss Elimination method	12. Gauss Sciedal Method
13. Jacob iteration method	14. Milnes Method
15. Runge Kutta Method	16. Divided Difference method

2. MATLAB 7

1. Bisection Method	2. Newton Raphson Method
3. Trapezoidal Rule	4. Simpsons one third rule
5. Power method	6. Regula Falsi
7. Steffensens Method	8. Muller method
9. LU decomposition	10. Gauss elimination
11. Gauss Sciedal	12. Langranges Method of interpolation
13. Chebyshev approximation	14. Richardsons extrapolation
15. Runge Kutta Method	16. Cubic spline approximation
17. Finite difference solution	18 Adams Moulton

Paper – M404

FUZZY LOGIC, ROUGH SETS AND APPLICATIONS

Full Marks-80+20=100

Unit-I(Fuzzy Logic and its Applications) (Marks-40)

1. **Fuzzy logic**: Classical logic-an overview, fuzzy propositions, fuzzy quantifiers, linguistic variables and hedges, Inference from conditional fuzzy propositions, inference from conditional and quantified propositions, inference from quantified propositions.
2. **Applications of fuzzy logic:**

(a) Fuzzy logic control and Applications, Modeling and control parameter, if-then rules, rule evalutions, conflict resolution, defuzzification, washing machine predate-prey system.

(b) Models of neurons: Neural and fuzzy machine intelligence, fundamental of neural networks, Fuzzy genetic Algorithms- basic concepts

(c) Fuzzy decision making and Fuzzy Delphi method forcasting.

Unit-II(Rough Sets and Applications) (Marks-40)

1. **Rough Sets** : Basic concepts of Rough sets, Approximation of sets, rough equality and rough inclusion of sets, comparison of rough sets, core, reduct, knowledge reduction. Algebraic and topological representation of rough sets, generalised approximation spaces, rough sets and Baye's theorem.
2. **Applications of Rough Sets** :

(a) Decision making, simplification of decision tables, decision algorithm, the case of Incomplete information.

(b) Data Analysis, flow graphs, the case of inconsistent data, data mining.

(c) Rough sets and conflict analysis, concepts of conflict theory and applications.

References:

1. G.J.Klir and B.Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India, 1995.
2. G.Bojadziev and M.Bojadziev, Fuzzy Sets, Fuzzy Logic, Applications, World Sci,1995.
3. Yen and Langani, Fuzzy Logic, Pearson Education, 2003.
4. Z. Pawlak, Rough Sets, Kluwer Academic Publishers,1991.

Paper – M405
FUZZY SET TOPOLOGY
Full Marks-80+20=100

Unit-I (Marks-40)

1. **Fuzzy topology** : Chang's definition and Lowen's definition, lower semi continuous and fuzzy topology, basic concepts- fuzzy open, fuzzy closed , fuzzy closure, fuzzy interior, fuzzy continuity, fuzzy filters and their convergences.

2. **New fuzzy topological space** : Subspaces, product spaces, quotient spaces, induced spaces.
3. **Separation axioms in fuzzy topological space** : Fuzzy T_0-space, fuzzy T_1-space, fuzzy Hausdorff spaces, fuzzy regular spaces, fuzzy normal spaces, properties of these spaces.

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Unit-II (Marks-40)

1. **Fuzzy compact spaces** : Different kinds of compactness in fuzzy topological spaces, comparison between different compactness, N-compactness and its properties.
2. **Fuzzy connected space and Fuzzy countability axioms** : Fuzzy countable axioms, q-separated sets, definition of fuzzy connectedness, examples and its properties, good extensions of connectedness.

References:

1. N.Palaniappan,Fuzzy Topology,Narosa,2006.
2. H.J.Zimmermann, Fuzzy Set Theory and its Applications , Allied Publishers Ltd.1991

Paper – M406
ADVANCED TOPOLOGY-II
Full Marks-80+20=100

Unit-I (Marks-40)

1. Zero-sets and their properties, cozero-sets, C-embedding and C^*-embedding, pseudo-compact space and its properties, Z-filters and Z-ideals, Z-ultrafilters.
2. Completely regular spaces in terms of zero-sets, convergence of Z-filters in C.R. space, Properties of C.R.-spaces.
3. Paracompact spaces : Types of refinements. Paracompact spaces-definition in term of locally finite refinement, Michael's theorem, fully normal spaces, Stone's coincidence theorem. Paracompactness in terms of open δ-refinement, δ-discrete open refinement, caushioned refinement etc. A.H.Stone's theorem: every metric space is paracompact, partition of unity and paracompactness, properties of paracompact spaces with regard to subspaces, product etc. Countably paracompact space and collectionwise normality.

Unit-II (Marks-40)

4. Locally compact spaces, properties of locally compact spaces, K-spaces, Alexandroff compactifications.
5. Compact space in terms of Z-filters, Stone-Cech compactification βX, construction of βX, applications of compactification theorem.
6. Real compact spaces, some characterizations, Lindelof space is real compact, homeomorphisms of real compact spaces, Hewitt realcompactification ν, properties of real compact soaces.

References:

1. Gillman and Jerison, Rings of Continuous Functions, Springer-Verlag,1976
2. Porter and Woods, Extensions and Absolutes of H'd spaces,Springer Verlag,1987
3. Alo and Shapiro,Normal Topological Spaces, Cambridge University Press,1974
4. J.Nagata,Modern Genaral Topology, North Holland
5. J.Dugundji,Topology,Prentice Hall of India,2003
6. C.E.Aull,Rings of Continuous functions,Marcel Dekker Inc.1985
7. R.C.Walker,The Stone-Cech Compactifications,Springer Verlag,Berlin,1974

Paper – M407
DIFFERENTIAL TOPOLOGY
Full Marks-80+20=100

Unit-I (marks-40)

1. **Manifolds**: Revision of Manifold theory in advanced level, quotient manifold, manifolds with boundary and corner. Surd's theorem and its consequences, Whitney's

embedding theorem and its consequences, homotopy of smooth maps, stability of smooth maps.

2. **Vector bundles on Manifolds**: Vector bundles, construction of vector bundles, homotopy property of Vector bundle, orientation, reduction of structure group of a vector bundle, homology characterisation of orientation.
3. **Transversality** : ε-neighbourhood of submanifold of Euclidean space, transvarsality, compact one-manifold and Brouwer's theorem, boundary and pre-image orientations, intersection numbers and degree of maps, Hopf degree theorem.
4. **Tubular Neibourhood** : Tubular neighbourhood theorems, collar neighbourhoos, isotropy extension theorem, uniqueness of tubular neighbourhoods, manifolds with corners and straightening them, construction of manifolds by gluing process.

Unit-II (Marks-40)

5. & 6. **Space of Smooth maps** : Space of jets, weak and strong topologies, continuity of maps between spaces of smooth maps, Spaces of immersions and embeddings, Baire properties of the space of smooth maps, smooth structures on jet spaces, Thom's transvesality theorem, multi-jet transvesality, Whitney's immersion and embedding theorems.
7. **Morse theory** : Morse functions, critical levels and attaching handles, Morse inequality, perfect Morse functions, Triangulations of Manifolds..
8. **Theory of Handle Representations** : Existence of handle presentation, Duality theorem, normalisation of presentation, cancellation of handles, classification of closed surfaces.

References:

1. A.Mukherjee,Topics in Differential Topology,Hindusthan Book Agency(2005)
2. M.W.Hirsch, Differential Topology, Springer
3. Guillmin and Pollak, Differential Topology, Prentice Hall, New Jersey(1974)
4. A.A.Kosinski,Differentiable Manifolds,Accademic Press(1993)

Paper – M408

TOPOLOGY OF FIBRE BUNDLES

Full Marks-80+20=100

Unit-I (Marks-40)

1. & 2. Coordinate bundles and fibre bundles, construction of a bundle from coordinate transformations, the product bundle, the Ehresmann-Feldbau definition of

bundle, differentiable manifolds and tensor bundles. Factor spaces of groups, the principle bundle and the principle map, associated bundles and relater bundles, the induced bundles.

3. & 4. Homotopies of maps of bundles, construction of cross sections, bundles having a totally disconnected group, covering spaces, Homotopy groups, the operations of π_1 on π_n , the homotopy sequence of a bundle. The classification of bundles over the n-sphere, universal bundles and the classification theorem.

Unit-II (Marks-40)

5. & 6. The fibering of spheres by spheres, the homotopy groups of spheres, homotopy groups of the orthogonal groups, characteristic map for the bundle R_{n+1} over S^n, characteristic map for the bundle U_n over S^{2n-1}. The homotopy groups of miscellaneous manifolds, sphere bundle over spheres, the tangent bundle of S^n , non-existence of fibering of spheres by spheres.

7. & 8. The stepwise extension of cross section, bundles of coefficients, cohomology groups based on a bundle coefficients, the obstruction cocycle, the difference cochain, extension and deformation theorem. The primary obstruction and the characteristic cohomology class, the primary difference of two cross sections, extensions of functions and the homotopy classification of maps. The Whitney characteristic classes of a sphere bundle, the Stiefel characteristic classes of differentiable manifolds.

References:

1. N.Steenrod, The Topology of Fibre Bundles, Princeton University Press,(1974)
2. D.Husemoller, Fibre Bundles, McGraw Hill(1975)
3. A.Mukherjee,Topics in Differential Topology,Hindusthan Book Agency(2005)
4. J.W.Milnor & J.D.Stasheff, Characteristic Classes, Hindusthan Book Agency(2005)
5. C.J.Isham,Modern Differential Geometry for Physisists, Allied(2002)
6. Yu.Borisovich, N.Bliznyakov, Ya.Izrailevich & T.Fomenko,Int. to Topology,Mir(1980)

Paper – M409
MECHANICS OF SOLIDS -II
Full Marks-80+20=100

Unit-I (Marks-40)

1. & 2**. Two-dimensional problems :** Plane stress, generalized plane stress, airy stress function, general solution of biharmonic equation, stresses and displacements in terms of complex potentials, simple problems, stress function appropriate to problems of plane

stress, problems of semi-infinite solids with displacements or stress prescribed on the plane boundary.

a. & 4. **Waves:** Propogation of waves in an isotropic elastic solid medium, waves of dilation and distortion, plane waves, elastic surface wave such as Rayleigh and Love waves **.**

Unit-II (Marks-40)

Variational methods: Theorems of minimum potential energy, theorem of minimum complementary energy, reciprocal theorem of Bett and Rayleigh, deflection of elastic string, central line of as beam and elastic membrane, torsion of cylinders, variational problem related to biharmonic equation, solution of Euler’s equation by Ritz, Galerkin and Kantorovich methods.

References:

1. I.S. Sokolnikoff,Mathematical theory of Elasticity, Tata McGrawHill, 1977
2. A.E.Love, A Treatise on the Mathematical Theory of Elasticity, Cambridge University Press,1963
3. Y.C.Fung, Foundations of Solid Mechanics, Prentice Hall, 1965
4. S.Timoshenko and N.Goodier, Theory of Elasticity, McGraw Hill, 1975
5. I.H.Dsames, Int. to Solid Mechanics, Prentice Hall, 1975
6. S.Valliappan, Continuum Mechanics, Oxford and IBH Publishing Co. 1981

Paper – M410

STOCHASTIC PROCESS

Full Marks-80+20=100

Unit-I (Marks-40)

1. **Stochastic Process**: Definition and examples, state space, stationary processes, Gaussian processes, Markov processes. **Random walk**:Simple random walk, general one-dimensional random walk in discrete time and continuous time.

2. **Markov chain**: Order of a Markov chain, Transition probability, Chapman-Kolmogorov equation, generalization of independent Bernoulli trials, classification of state and chain, determination of higher transition probabilities, stability of Markov system, Markov chain with countable state space, Markov chain with continuous state space.
3. **Markov processes with discrete state space and continuous time**: Transition probability, Chapman-Kolmogorov equation, Poisson process, properties of Poisson processes. Generalization of Poisson processes: Poisson cluster process, pure birth process,birth-immigration process,time dependent Poisson process,birth & death process.
4. **Markov processes with continuous state space and continuous time**: Diffusion process, Wiener process, diffusion equations for the Wiener process, first passage `Kolmogorov equation, boundary conditions for homogeneous diffusion process, Ornstein-Uhlenbeck process, transformation of Wiener process, first passage times for homogeneous diffusion processes, approximation to discrete process by means of diffusion processes, continuous and jump transitions.

Unit-II (Marks-40)

5. **Renewal Processes**: Renewal process, Renewal process in discrete time and in continuous time, Renewal equations, stopping time : Wald's equation, Renewal theorems, Delayed and equilibrium renewal processes, residual and excess lifetimes, Renewal reward process, alternating renewal process, regenerative renewal processes, regenerative inventory system.
6. **Markov Renewal and Semi-Markov Processes**: Definitions and preliminary results, Markov renewal equation, limiting behaviour, first passage time. **Stationary Processes and Time Series**: Models of time series, Time and frequency domain: power spectrum, statistical analysis of time series.
7. **Branching Processes**: Properties of generating functions of Branching processes, probability of extinction, distribution of total number of progeny, conditional limit laws, generalisation of the classical Galton-Watson process, continuous-time branching process. **Stochastic calculus**: Stochastic limit and mode of convergence, convergence of stochastic products, stochastic derivatives, stochastic integration-mean square Riemann integrals, stochastic differential equations, examples.
8. **Stochastic Processes in Queuing and Reliability** : General concept of queueing system, the queueing model M/M/1, transition behaviour of M/M/1 model, birth and deth processes in queueing theory: Multichannel model, non-birth and death queueing processes, network of Markovian queueing system.

References:

1. J.Medhi: Stochastic Process: New Age Pub. House. 2001
2. A.K.Basu, Int. to Stochastic Process, Narosa , 2005.
3.D.R.Cox&H.D.Miller:The Theory of Stochastic Processes,Chapman and Hall,London 1965
4. S. Mehata: Stochastic Processes, Tata McGraw-Hill, 1976.
5. S.M.Ross: Stochastic Processes, John Wiley & Sons,INC,(1995).