2 Year M.Sc. (Mathematics) Programme

Department of Mathematics,
Birla Institute of Technology,
Mesra, Ranchi – 835215,
Jharkhand

Two Year M. Sc. in Mathematics

Revised Course Structure and Syllabus

First Semester:

Sl. No.	Subject Code	Offering Department	Name of the Subject	L	T	P	Credit
1.	SAM1101	AM	Ingredients of Applied Mathematics	3	1	0	4
2.	SAM1103	AM	Real Analysis	3	0	0	3
3.	SAM1105	AM	Classical Mechanics and Hydrostatics	3	0	0	3
4.	SAM1107	AM	Probability and Statistics	3	0	0	3
5.	TCS1021	CS	Data Structure	3	0	0	3
6.	TCS1022	CS	Data Structure lab	0	0	3	2
7.	SCS 1052	CS	Progamming Lab in C	0	0	3	2
							20

Second Semester:

Sl. No.	Subject Code	Offering Department	Name of the Subject	L	T	P	Credit
1.	SAM2101	AM	Discrete Mathematical Structure	3	1	0	4
2.	SAM2103	AM	Modern Algebra	3	0	0	3
3.	SAM2105	AM	Complex Analysis	3	0	0	3
4.	SAM2107	AM	Riemannian Geometry and Differential Geometry	3	0	0	3
5.	SAM2109	AM	Advanced Numerical Methods and Difference Equations	3	1	0	4
6.	ARC8037	Arch	Disaster Management (Breadth Paper)	3	0	0	3
							20

Third Semester:

Sl. No.	Subject Code	Offering Department	Name of the Subject	L	T	P	Credit
1.	SAM3101	AM	Operation Research	3	0	0	3
2.	SAM3103	AM	Hydrodynamics and Potential Theory	3	1	0	4
3.	SAM3105	AM	Topology and Functional Analysis	3	1	0	4
4.	SAM3107	AM	Number Theory and its Applications	3	0	0	3
5.		AM	Elective-I	3	0	0	3
6.		AM	Elective-II(free)	3	0	0	3
							20

Forth Semester:

Sl. No.	Subject Code	Offering Department	Name of the Subject	L	T	P	Credit
1	SAM4101	AM	Project /Dissertation				20

Total credits in 4 semesters:--80

List of Electives:

Elective I

1. SAM 3109 Advanced PDE & Boundary Value Problem
2. SAM 3111 Mathematical Logic & Logic Programming
3. SAM 3113 Mathematical Modeling & simulation
4. SAM 3115 Finite Element Method

Elective II (Free)

1. SAM 3117 Artificial Neural Network and Fuzzy Logic
2. SAM 3119 Mechanics of Solids
3. SAM 3121 Boundary Layer Theory
4. SAM 3001 Computational Fluid Dynamics

Detailed Syllabus :

FIRST SEMESTER

SAM 1101 INGREDIENTS OF APPLIED MATHEMATICS (3-1-0-4)

Module I

Boundary value problems, classification of partial equations, Variety of Boundary conditions, like Dirichlet conditions, Neumann conditions, Cauchy condition etc. D'Alembert's solution of the Wave Equations. (10 L)

Module II

Sturm-Liovrille problem, Orthogonally of Eigen-functions. Eigen function expansion.Bessel function of 1^{st} kind and its properties. Legendre polynomials and its properties. Associated Legendre polynomials. Hyper geometric functions and its properties. (10 L)

Module III

Laplace Transform of Impulse, periodic function etc. Inverse Laplace Transform, Convolution Theorem, Application of Laplace Transform in solving Ordinary and Partial Differential Equations. Fourier Transformation:- Fourier sine and cosine transform. (8 L)

Module IV

Simple application conversion of a Linear Differential Equation to an Integral Equation and vice-versa. Solution of Integral Equation. Integral Equation of the convolution type. Abel's Integral Equation. Integro-differential equations. (8L)

Books:

1. I. N. Sneddon, Special Functions of Mathematical Physics and Chemistry, Oliver and Boyd, 1956.
2. C. J. Tranter, integral Transforms in Mathematical Physics, Methuen, 1956.
3. P. M. Morse and H. Feshback, Methods of Theoretical Physics. Vols. 1 and 2, McGraw-Hill, 1952.
4. L. A. Pipes, Applied Mathematics for Engineering and Physics, McGraw-Hill, 1958.
5. G. F. Simmons, Differential Equations, Tata McGraw-Hill, 1994.

SAM 1103 REAL ANALYSIS (3-0-0-3)

Module I:
Elementary set theory, finite, countable and uncountable sets. Real number systems as a complete ordered field. Archimedean properties, spectrum, infremum. Bolzano Weirstrass theorem, Heine Borel theorem. (8 L)

Module II:
Riemann sums and Riemann integral, definition and existence of Riemann-steiltjes integral, Properties of integral, integration and differentiation, the fundamental theorem of calculus, Rearrangements of terms of a series, Riemann's theorem. (8 L)

Module III:
Lebesgue outer measure, Measurable sets, Regularity, Measurable functions, Borel and Lebesgue Measurability, Non-measurable sets. Integration of Non-negative functions functions. The general integral. Integration of series. Reimann and Lebesgue integrals. Functions of Bounded variation, Lebesgue Differentiation Theorem. Differentiation and Integration. (10 L)

Module IV:
Measures and outer measures, Extension of a measure. Uniqueness of Extension. Completion of a measure. Measure spaces. Integration with respect to a measure. Lebesgue's Monotone Convergence theorem, Fatou's lemma, Dominated Convergence theorem. The L^P spaces. Convex functions. Jensen's inequality. Completeness of L^P, Convergence in Measure. (10 L)

Books:

1. G. F. Simmons, Elements of Topology and Modern Algebra.
2. Walter Rudin, Principle of Mathematical Analysis, McGraw-Hill Ld., 5th Ed., 2003.
3. H. L. Royden, Real Analysis, McMillan Pub. Co. Inc.., 4th ed., 1997.

SAM 1105 CLASSICAL MECHANICS AND HYDROSTATICS (3-0-0-3)

Module I :
Motion of a particle in a central field, stability of orbits and disturbed orbits, deduction of Kepler's laws. D'Alembert's principle, compound pendulum. (8 L)

Module II:
Langrange's Equations, small oscillations, Elements of calculus of variations, Hamilton's principle, principle of least action, Fermat's principle, Brachistochrone's problem. (10 L)

Module III:
Lagrange and Poisson Brackets, contact transformation, Elements of Hamilton Jacobi theory. (8 L)

Module IV:
Determination of C. P. with the help of multiple integrals (standard problems) Rotating liquids, atmospheric pressure, convective equilibrium. (10 L)

Books:

1. Classical Mechanics- Goldstein , 3rd ed, Pearson Education India
2. Classical Mechanics: 2nd Ed., Herbert Charles Corben, Philip Stehle, DoverPublications
3. **Hydrostatics: A.S.Ramsay**

SAM 1107 PROBABILITY AND STATISTICS (3-0-0-3)

Module I:
Probability as a Set Function, Borel Field (a-field) and Extension of Probability Measure, Notion of a Random Variable and Distribution Function, Multidimensional Random Variable, Conditional Probability and Statistical Independence, Conditional Distribution of a Random Variable Convergence of a Sequence of Random Variables, Weak and Strong Law of Large Numbers.

Mathematical Expectation and Moments of Random Variables - Properties of Mathematical Expectation, Moments, Conditional Expectation, MGF, Characteristic Function, Inversion Theorems. (10L)

Module II:
Discrete probability models: Geometric, Hypergeometric, Negative Binomial Continues Probability Models:- Univariate Models - Exponential Distribution, Gamma Distribution, Beta Distribution, Cauchy Distribution, Student's t Distribution as sampling distribution, Chi-Square and F distribution, Tests of significance based on Normal, t, Chi-Square, F. (8L)

Module III:
Estimation: unbiasedness, consistency, efficiency, sufficiency, Minimum variance unbiased estimation, method of maximum likelihood, method of moments, minimum chi-square Testing of hypothesis, Neymann Pearson Lemma, Idea of Parametric and non parametric tests (8L)

Module IV:
Sampling Techniques: Simple Random Sampling with and without replacement, Stratified random sampling, cluster sampling, systematic sampling, sampling and non-sampling errors. Design of experiments: Completely Randomized Design, Randomized Block design, Latin Square Design, Idea of factorial experiments. Applied Regression Analysis: Linear estimation under Gauss-Markoff setup. (10 L)

Books:-

1. An Introduction to Probability Theory and its Applications Vol. 1 by W. Feller.
2. Fundamentals of Mathematical Statistics by S. C. Gupta & V. K. Kapoor.
3. Fundamentals of Applied Statistics by S.C. Gupta and V. K. Kapoor Sampling Techniques by Cochran.
4. Design and Analysis of Experiments by Das and Giri.
5. Applied Regression Analysis by N. Draper and H. Smith.

TCS 1021 **DATA STRUCTURES** **(3-0-0-3)**

MODULE – I

Algorithms and Analysis of Algorithms: Definition, Structure and Properties of Algorithms, Development of an Algorithm, Data Structures and Algorithms, Data Structure – Definition and Classification, Efficiency of Algorithms, Apriory Analysis, Asymptotic Notations, Time Complexity of an Algorithm using *O* Notation, Polynomial Vs Exponential Algorithms, Average, Best and Worst case Complexities, Analyzing Recursive Programs, Open source software development process. **[5]**

MODULE – II

Arrays, Stacks and Queues: Array Operations, Number of Elements in an Array, Representation of Arrays in Memory, Applications of Array, Stack-Introduction, Stack Operations, Applications of Stack, Queues-Introduction, Operations on Queues, Circular Queues, Other Types of Queues, Applications of Queues. [5]

MODULE – III

Linked List, Linked Stacks and Linked Queues: Singly Linked Lists, Circularly Linked Lists, Doubly Linked Lists, Multiply Linked Lists, Applications of Linked Lists, Introduction to Linked Stack and Linked Queues, Operations on Linked Stacks and Linked Queues, Dynamic Memory Management and Linked Stack, Implementations of Linked Representations, Applications of Linked Stacks and Linked Queues. [5]

MODULE – IV

Trees, Binary Trees, BST, AVL Trees and B Trees: Trees: Definition and Basic Terminologies, Representation of Trees, Binary Trees: Basic Terminologies and Types, Representation of Binary Trees, Binary Tree Traversals, Threaded Binary Trees, Applications, BST & AVL Trees: Introduction, BST: Definition and Operations, AVL Trees: Definition and Operations, B Trees: Introduction, m-way search trees: Definition and Operations, B Trees: Definition and Operations. [6]

MODULE – V

Graphs: Introduction, Definitions and Basic Terminologies, Representations of Graphs, Graph Traversals, Single-Source Shortest-Path Problem, Minimum Cost Spanning Trees. [5]

MODULE – VI

Sorting: Introduction, Shell Sort, Quick Sort, Heap Sort. [5]

MODULE – VII

Searching: Introduction, Binary Search, Transpose Sequential Search, Interpolation Search. [5]

Text Book:

1. G A V Pai – Data Structures and Algorithms: Concepts, Techniques and Applications, 2nd Edn, Tata McGraw-Hill, 2008
2. Horowitz E.Sahni, S., Susan A., Fundamentals of Data Structures in C, 2nd Edition, University Press, 2010

Reference Books:

1. J. P. **Tremblay ,** P. G. **Sorenson – An Introduction to Data Structures With Applications, 2nd Edn,** McGraw-Hill, Inc. New York, NY, USA.
2. Seymour Lipschutz – Data Structures, 6th Edn, 9th Reprint 2008, Tata McGraw-Hill.
3. Adam Drozdek – Data Structures and Algorithms in C++, Thomson Learning, New Delhi – 2007.
4. J. Feller, B. Fitzgerald -Understanding Open Source Software Development, Pearson Education Ltd. New Delhi

TSC1022 DATA STRUCTURE LAB (0-0-3-2)

SCS 1052 PROGAMMING LAB IN C (0-0-3-2)

SECOND SEMESTER

SAM 2101 Discrete Mathematical Structure (3-1-0-4)

Module I

Discrete Mathematics:

Logic and Mathematical Reasoning: Logic, Propositional Equivalences, Predicates and Quantifiers, Methods of Proof, Mathematical Induction, Recursive Definition and Algorithms, Program Correctness.

Permutation, Combination, Use of generating function as enumerator of permutation and combination, Ordering of permutations and combination.

Principles of Counting and Algorithms: The Principle of Inclusion – Exclusion, the Addition and Multiplication Rules, The Pigeon-Hole Principle.

Recurrence Relations and their solutions using generating function. (8L)

Module II

Relation, Equivalence relations, Partial Ordering Relations and Lattices,

Subgroups, Groups and Coding: Binary Operations, Semi groups, Products and Quotients of Semi groups, Groups, Product and Quotients of Groups, Coding of Binary Information and Error Correction, Decoding and Error Correction. Language and Grammar (8L)

Module III

Graph theory:

Definitions of basic terminologies, isomorphism, connected & disconnected graphs, Euler & Hamilton graphs.

Tree: Properties and basic terminologies, spanning tree.

Cut sets: Properties, Fundamental circuits and cut sets, connectivity, separability, network flows.

Planar and dual graphs: Combinational representation, planar graphs, Kuratowshi's graphs, detection of planarity, dual graphs. (10L)

Module IV

Matrix representation of graph: adjacency matrix, incidence matrix, circuit matrix, cut set matrix, path matrix fundamental matrices, and relationships among matrices.

Coloring, covering & partioning: Chromatic number, chromatic portioning, matching, covering, four color problem.

Directed graphs: Different types, directed path, and connectedness, Euler digraphs, trees, matrix representation, tournament.

Graph theoritic algorithms: Algorithms for connectedness, a spanning tree, fundamental circuits, cut vertices, directed circuits, shortest paths.

Applications: graph in sequential switching networks, graph in coding theory, graph in Markov process, graphs in computer programming. (10L)

Text Books:

1. **Mott , Abraham & Baker** : Discrete Mathematics for computer scientist & mathematicians PHI, 2nd edition 2002.
2. **C.L.LIU :** Elements of Discrete maths, Mcgraw Hill, 2nd edition, 2001.
3. **ROSS & WRIGHT :** Discrete Mathematics PHI 2nd edition , 1988.
4. Kolman, Rusby, Ross: Discrete Mathematics Structures, PHI, 5th ed, 2005

SAM 2103 MODERN ALGEBRA (3-0-0-3)

Module I

Normal subgroup, Quotient groups, cyclic groups, Homomorphism, Automorphism, cayley's theorem, sylow's theorem, Direct products, Finite Abelian groups, Fundamental theorem of homomorphism of groups. (8 L)

Module II

Ring, Homomorphism, Ideals and quotient rings, the field of quotient of an Integral Domain, Euclidean and polynomial ring, polynomials over the rational field, polynomial rings over commutative ring. (8L)

Module III

Vector spaces and modules, Elementary concepts, linear independence and bases, Dual spaces, Inner product spaces. Fields-Extension Fields, Roofs of polynomials, the elements of Galois theorem, solvability of Radicals. (10 L)

Module IV

Linear transformation – Characteristic root, matrices, canonical form, triangular form, Nilpotent transformations.

A Decomposition of V : Jordon form, Rational canonical Forms; Hermitian Unitary and Normal Transformations, Real quadratic forms. (10 L)

Books:

1. IN Herstein, Topics in Algebra, 2nd ed., John Wiley, 1999.
2. Hoffmann and Kunj, Linear Algebra, Pearson Education, 3rd ed, 2008
3. J.B. Fralieigh, A first course in Abstract algebra, 5th ed., Addison-wesley, 1994.
4. Henry Helson, Linear Algebra; Hindustan Publishing House, 1994.

SAM 2105 COMPLEX ANALYSIS (3-0-0-3)

Module I

Complex integration: Line integral, Cauchy Goursat theorem, simply and multiply – connected domain, Morera's theorem, Cauchy's Integral formula, Poisson's Integral Formula, Derivatives of analytic function, Cauchy's inequality, Liouville's theorem, Taylor's and Laurent's series. (10 L)

Module II

Essential singularities and poles, calculus of Residues, Cauchy's theorem of Residues, Branch points and Branch cut, Integration around a Branch point and cut, poles and Zeros of a meromorphic function, the argument principle, Rouche's theorem, Maximum modules theorem, Fundamental theorem of Algebra. (10 L)

Module III

Expansion of a meromorphic function, mittaga Leffler's expansion theorem, applications to trigonometric functions, Conformal mapping and its Applications, Schwartz – Christoffel Tranformations. (8 L)

Module IV

Analytical continuation and its uniqueness, convergence of series and sequences, uniform convergence of power series of complex functions, Integration and Differentiation of power series. Radius of convergence. (8L)

Books:

1. L. V. Ahlfors, Complex Analysis, 3rd ed., McGraw-Hill, 1979
2. R. V. Churchill, Complex Variable and Applications, McGraw-Hill, 2006.
3. E. C. Titchmarsh, theory of Functions.

SAM 2107 RIEMANNIAN GEOMETRY AND DIFFERENTIAL GEOMETRY

(3-0-0-3)

Module I

Introduction to Tensor, Contravariant and covariant vectors and tensors, Mixed tensors, Inner product, Outer product, Contraction, Quotient law, symmetric and skew symmetric tensor, relative tensor, group properties. (10 L)

Module II

Riemanian Metric, Christoffel symbols, covariant differentiation of vectors, gradient, divergence, curl and Laplacian of tensors. (8 L)

Module III

Serret Frenet formulae, spherical curvature, uniqueness theorem, spherical indicatrix, Involutes and Evolutes, Bertrand Curves, Envelopes, Developable Surfaces, Characteristics, edge of regression, curvilinear co-ordinates, First and second order magnitudes. (10 L)

Module IV

Weingarten's relations, Curvature of normal section, lines of curvature, Euler's theorem, Rodrigue's formula, Surface of revolution, Conjugate system, Asymptotic lines, equations of Gauss and Codazzi, elementary idea of Geodesics. (8 L)

Books

1. Differential geometry of curves and surfaces/ by Manfredo P. Do Carmo- NJ: Prentice-Hall, 1976, viii, 503p.
2. Introduction to Geometry of Manifolds with Symmetry (Hardcover), by V. V. Trofimov et. al., Springer; 1st edition (Feb 28, 1994), 340 pages.
3. Differential Geometry by C. E. Weaherbun, Radha Publications.
4. Reimannian Geometry by C. E. Weaherbun, Radha Publications.

SAM2109 ADVANCED NUMERICAL METHODS AND DIFFERENCE EQUATIONS
(3-1-0-4)

Module I
Review of Numerical solution of systems of Linear and Non-linear Equations, solution of Iridiagonal system, Gaussian Quadrature formula, Gauss-Legendre Formula: Two point and three point Rules, Numerical Multiple Integration: Double and Triple Integrations.
[Exposure of Numerical solutions of Integral Equations]
Numerical solution of simulataneous. (10L)

Module II
First order Ordinary Differential Equations and higher order Ordinary Differential Equation, Applications to initial and Boundary Value problems, Numerical solution of partial Differential Equation: Laplace and poison Equations, Ideal conduction Equation and Wave Equation, Applications of Boundary Value problems. (10L)

Difference equation:

Module III
Formation of Different Equation, Linear Difference Equation, conversions of or Reduction of Difference Equation to Linear form, simultaneous Difference Equations with constant coefficients. (8L)

Module IV
Applications of Difference Equations in respect to Boundary Value Problems, Computational problem of difference Equation, Boundary Value Problem of second order Difference Equation. (8L)

Books:

1. Introductions to Difference Equations, Samule Goldbarg. Dover Pulications.
2. Modelling with Differential and Difference equations, Gleen Fulford, Peter Forrester, Cambridge University press, 1997
3. Advanced topics in Difference Equations, Ravi Agarwal and Praticia J. Y. Wang, Kluwar Academic Press
4. Numerical Methods for Scientists and Engineers, Richard W. Hamming, Dover Pulications,1986.
5. Analysis of Numerical Methods, Eugene Isaacson, Herbert Bishop Keller, Dover Pulications, 1994.

ARC8037 Disaster Management (3-0-0-3)

Module 1

Natural Hazards and Disasters. Concept of Environmental Hazards, Environmental stress & Environmental Disasters. Types of Environmental hazards & Disasters: Natural hazards and Disasters, Earthquake Hazards/ disasters, - Causes of Earthquakes, - Distribution of earthquakes, - Hazardous effects of earthquakes, Earthquake Hazards in India, Human adjustment, perception & mitigation of earthquake. (8L)

Module II

Overview of Disaster Management – Distinguishing between an emergency and a disaster situation. Disaster Management Cycle – Phase I: Mitigation, and strategies; hazard identification and vulnerability analysis. Disaster Mitigation and Infrastructure, impact of disasters on development programmes, vulnerabilities caused by development, developing a draft countrylevel disaster and development policy (8L)

Module III

Disaster Management Cycle – Phase II: Preparedness, Disaster Risk Reduction(DRR), Emergency Operation Plan (EOP), Mainstreaming Child Protection and Gender in Emergency Planning, Assessment (8L)

Module IV

Disaster Management Cycle – Phases III and IV: Response and recovery, Response aims, Response Activities, Modern and traditional responses to disasters, Disaster Recovery, and Plan , Disasters as opportunities for development initiatives (6L)

Module V

Community based Initiatives in Disaster management, need for Community Based Approach, categories of involved organizations: Government, Nongovernment organisations (NGOs), regional and international organizations, panchayats, community workers, national and local disaster managers, Policy Makers, grassroots workers, methods of dissemination of information, Community based action plan, advantages/disadvantages of the community based approach.(6L)

Books:

1. Carter, W. Nick, Disaster Management – A Disaster Manager's Handbook, A.D.B., Manilla, Philippines, 1991.
2. Cutter, Susan L. (Ed.): Environmental Risks and Hazards, Prentice Hall, New Delhi, 1999.
3. Garlake, Teresa, Dealing with Disasters, Oxfam, Oxford, 2000.
4. Government of India, An Action Plan to bring about Collaborative Relationship between Voluntary Organizations and Government, CAPART, Government of India, New Delhi, 1994.
5. Government of India/United Nations Development, Disaster Risk Management Programme (2002-07): Community Based Disaster Preparedness and Risk Reduction Through Participation of Committees and Local Self Governments.
6. Modh Satish Citizens Guide to Disaster Management: How to Save your own life and help others, McMillan India 2006.
7. Mutchopadhaya, A.K., Crisis and disaster management turbulence and aftermath, Newage

International Publications, New Delhi, 2005.

THIRD SEMESTER

SAM 3101 OPERATION RESEARCH (3-0-0-3)

Module I

Linear Programming Extensions: Introduction to Linear Programming, Graphical and Simple Method, Revised Simplex Method, Computational Procedure of the revised simplex method, Bounded variable Technique. (8L)

Module II

Project Management: Scheduling a project with PERT/CPM, Time cost trade offs, Scheduling and controlling project costs, Evaluation of PERT/CPM.

Sequencing Problem: Introduction, Problem with n jobs and 2 machines, Problem with 2 jobs and m machine, Problem with n jobs and m machines. (10L)

Module III

Dynamic Programming: Deterministic Dynamic Progamming, Stochastic Dynamic Progamming. Integer Programming: Introduction, Binary Integer Programming. The Gomory's Algorithm, Branch and Bound Method.

Non linear Programming: Introduction, Gradient and Hassian Matrix, General Non-linear Programming Problem, NLPP with and without constraints, Karush-Kuhn-Tucker conditions. (10L)

Module IV

Queuing Theory: Introduction, Queuing system, Characteristic of Queuing system, Kendall's notations, Queuing models based on Birth and Death Process. (8L)

Books:

1. Hiller, F. S. and Leiberman, G. J. (2007), 8th ed.; Introduction to Operation Research; Tata McGraw-Hill.
2. Taha, H. A. (2005), 7th ed.; Operational Research: An Introduction, Pearson Education.

SAM 3103 HYDRODYNAMICS AND POTENTIAL THEORY (3-1-0-4)

Module I

Eulerian and Lagrangian method, equation of continuity in different co-ordinates system, boundary surface, Helmholtz's vorticity equation of motion, Bernoulli's equation, Cauchy's Integrals. (10L)

Module II

Two dimensional motion, source, sink and doublet, Images, Theorem of Blasius, Vortex motion, Kerman Vortex sheet. (8L)

Module III:

Motion of circular and elliptic cylinder, motion of a sphere in sample cases. (8L)

Module IV:

Laws of Newtonian Attraction, Attraction and potential of a rod, circular disc, spherical shell and solid sphere. Gauss's and Poisson's Equation of matter and Equipotential Surfaces. (10L)

Books:

1. **A treatise on hydromechanics, part 1,** William Henry Besant Deighton, Bell, 1891
2. **An elementary treatise on hydromechanics**: with numerous examples:5th ed., Edward Albert Bowser, D. Van Nostrand, 1899
3. **Hydromechanics**: Besant & Ramsay
4. **NutonanAttraction**: A S Ramsay
5. **Sactics**: S L Loney

SAM 3105 TOPOLOGY AND FUNCTIONAL ANALYSIS (3-1-0-4)

Module I

Topology: Metric Spaces, Open and Closed Sets, Convergence, Completeness and Baire's Theorem, Cantor's Intersection Theorem, Continuous Mappings, Spaces of Continuous Functions, Topological Spaces, Open Bases and Open Sub-bases, Weak Topologies, Compactness, Compact Spaces, Product of Spaces, Tychonoff's Theorem. (10L)

Module II

Totally compact Spaces, Ascoli's Theorem, T_1 Spaces and Hausdorff Spaces, Urisohn's Lemma and Tietze Extension Theorem, The Urisohn Imbedding Theorem, Connected Spaces, Totally Disconnected and Totally Connected Spaces. (10L)

Module III

Functional Analysis: Branch Spaces, Continuous Linear Transformation, The Hahn-Branch Theorem, The Open Mapping Theorem, Closed Graph Theorem, Hilbort Spaces. (8L)

Module IV

Orthogonal Complements, Orthogonal sets, Adjoint of an operator, Self-adjoint operators, Normal and Unitary operators, Projections. (8L)

Text-book :

1. Kreyzig., E., Introductory Functional Analysis with Applications, John Wiley (2001)
2. Bachman G. and Narici L., Functional Analysis, Academic Press (1966)
3. Cryer Collin W., Numerical Functional Analysis, Oxford University Press
4. Simmons, G.F., An Introduction to Topology and Modern Analysis, McGraw-Hill
5. Taylor, A.E., Introduction to Functional Analysis, Wiley (1958)
6. Wilansky, A., Functional Analysis, Blaisdell (1964)
7. J Dugundji – Topology, PHI
8. M Eisenberg – Topology (Holt, Rinehart and Winston)
9. J L Kelley –General Topology (Von Nostrand)
10. G F Simmons – Introduction to Topology and Modern Analysis (McGraw Hill)
11. Steen & Seebach – Counterexamples in Topology (Holden Day)
12. S Willard –General Topology (Addison Wesley)

SAM3107 Number Theory and its Applications (3-0-0-3)

Module I

Unique Factorisaton in $\mathbb{Z}$ (and Id's) Euclidean Algorithm., Application to linear Diophantine equations. Arithmetic functions Primality Testing and factorization algorithms, Pseudo-primes, Fermat's pseudo-primes, Pollard's rho method for factorization, Continued fractions, Continued fraction method Hash Functions. (8L)

Module II

Arithmetic in Quadratic Number fields: Integers, Units Primes and irreducible elements, Failure of unique factorization, (Informal) definition of Ideal class group, Pell's equation and relation to continued fractions. Diophantine equations problems: Use of congruence, Fermat equations. (8L)

Module III

Introduction to algebraic integers. Algebraic and Transcendental numbers : Lioville's theorem, Transcendence of (and of without proof) Dedekind theory of ideals with emphasis on algebraic integers.

A. Integral Extensions, Algebraic extension, algebraic Number fields. Norms and traces, discriminant.

B. Dedekind domains, Integral closure of a Dedekind domain is a Dedekind domain, Integers in number fields: Quadartic and Cyclotomic integers.

C. Ideal class group, finiteness, Dirichlet's theorem on units.

D. Splitting of primes in a extension field. Discriminant and ramification, examples of quadaratic and cyclotomic integers.

E. Quadratic Reciprocity using Gaussian sum. (10L)

Module IV

Analytic aspects :

A. Divergence of/p, Euler's theorem, zeta function, statement of prime number theorem, Bertrand's postulate.

B. Dirichlet's theorem on primes in Arithmetic progression. C. Dedekind's Zeta function, Class number formula for quadratic number fields. (10L)

Books:

1. Nathanson, Melvyn B.: "Additive number theory; The classical bases", Graduate Texts in Mathematics, 164. Springer-Verlag, New York, 1996. 342 pp. ISBN 0-387-94656-X
2. Number-theoretic properties of partitions are included in the extensive book by Andrews, George E.: "The theory of partitions", Encyclopedia of Mathematics and its Applications, Vol. 2, Addison-Wesley Publishing Co., Reading, Mass.-London-Amsterdam, 1976. 255 pp.
3. W.S. Burnside and A.W. Panton, The Theory of Equation, 3rd Ed., S.Chand & Co.Ltd., New Delhi, 1979.

Elective I

SAM 3109 **Advanced Partial Differential equations** **(3-0-0-3)**

Module 1: Introduction:

Basic Concepts and Definitions, Mathematical Problems, Linear Operators, Superposition Principles, Classifications and constructions of first order differential equations, Geometrical interpretation of a first order differential equation, Canonical forms of first order differential equations, Classification of second order Linear Equations: Second order linear equations with two independent variables, canonical forms. (8L)

Module 2: Eigen Value Problems and Special Functions:

Sturm- Liouville Systems, Eigen Values and Eigen functions, Eigen value expansions, Convergence in the Mean, Completeness and Parseval's Equality, Singular Sturm-Liouville systems, Boundary Value Problem involving Ordinary Differential Equations, Green's function for Ordinary Differential Equations, Construction of Green's function, The Scrodinger Equations and Linear Harmonic Oscillator. (10L)

Module 3: Green's Function for Boundary Value Problems and Applications:

Boundary Value Problems, Maximum and Minimum Problems, Uniqueness and continuity problems, Dirichlet Problems for a Circle, Dirichlet Problems for a Circular Annulus, Neumann Problem for a Circle, Dirichlet problem for a rectangle, Dirichlet problem involving the Poisson Equations, The Neumann problem for a rectangle. The Dirac Delta Function, Properties of Green's function, Methods of Green's function, Dirichlet's Problem for the Laplace Operator, Dirichlet's Problem for the Helmholtz Operator (10L)

Module 4: Nonlinear Partial Differential Equations with Applications

One dimensional wave equations and method of characteristics, Linera Dispersive Waves, Nonlinear Dispersive Waves and Whitham's Equations, Nonlinear Instability, The Traffic Flow Model, Flood Waves in Rivers, Riemann's Simple Waves of Finite Amplitude, Discontinuous Solutions and Shock Waves, (8L)

Text Book:

1. Linear Partial Differential Equations for Scientists and Engineers, Lokenath Debnath and Tyn Myint U., Fourth Edition, Birkhauser, Boston.
2. I.N.Sneddon, Elements of Partial Differential Equations, **McGraw Hill, NewYork.**

SAM 3119 Mathematical Logic & Logic Programming (3-0-0-3)

Part I:

Module I

Programming Prolog: facts, simple queries, complex queries, rules, arithmetic operators, recursion, unification, lists, cut.

Propositional logic: Boolean functions and formulas, syntax, semantics, laws of deduction, normal forms, resolution, theorem proving, validity, soundness and completeness. (8L)

Module II

First order logic : conversion of commonsense sentences into the language of first order logic, universal and existential quantifiers : syntax, terms of predicate, model theoretic semantics, Harbrand universe, normal form, unification, Proof theory, mechanical theorem proving, incompleteness. (10L)

Part II:

Module III

Formal theories, consequence and deduction.

Classical Propositional Calculus: Syntax, truth, validity, Adequacy of connectives, normal forms, applications to circuit design, Axiomatic treatment, deduction theorem, derived rules of inference, Soundness, Independence of axioms, Consistency, completeness, Completeness w.r.t. Boolean algebras. (10L)

Module IV

Computer-assisted formal proofs: tableaux, resolution. Classical first order theories: Syntax, satisfaction, truth validity, Axiomatic treatment, Equality. (8L)

1. **A Concise Introduction to Mathematical Logic** By Wolfgang Rautenberg,v Springer, 2009
2. **Introduction to Mathematical Logic** By Elliott Mendelson 4th Ed. Chapman & Hall, 1997
3. **Introduction to mathematical logic** Alonzo Church Princeton University Press, 1996

TSC 2101 **Mathematical Modeling & Simulation (3-0-0-3)**

Module I

Introduction

Models, reality, Properties of models, model classification and characterization, steps in building mathematical models, sources of errors, dimensional analysis.

Modeling using Proportionality, Modeling using Geometric similarity; graphs of a functions as models.

Model Fitting – Fitting models to data graphically, Analytic methods of model fitting, Applying the least square criterion,

Experimental Modeling – High order polynomial models, Cubic Spline models. (10L)

Module II

Discrete Probabilistic Modeling –Probabilistic modeling with discrete system; Modeling components & System Reliability; Linear Regression.

Discrete Optimization Modeling – Linear Programming – Geometric solutions, Algebraic Solutions, Simplex Method and Sensitivity Analysis. (8L)

Module III

Modeling with a Differential Equations – Population Growth, Graphical solutions of autonomous differential equations, numerical approximation methods-- Euler's Method and R.K. Method.

Modeling with systems of Differential Equations – Predator Prey Model, Epidemic models, Euler's method for systems of Differential equations. (8L)

Module IV

Simulation Modeling – Discrete-Evvnt Simulation, Generating random numbers; Simulating probabilistic behavior; Simulation of Inventory model and Queueing Models using C program. Other Types of simulation—Continuous Simulation, Monte-Carlo simulation. Advantages, disadvantages and pitfalls of simulation

Case Study: Case Studies for various aspects of Modeling to be done. (10L)

Text Books

1. Frank R. Giordano, Mawrice D Weir, William P. Fox, A first course in Mathematical Modeling 3rd ed3 2003. Thomson Brooks/Cole, Vikas Publishing House (P) Ltd.
2. J.D. Murray, Mathematical Biology – I, 3rd ed2 2004, Springer International Edition
3. J.N. Kapoor, Mathematical Models in Biology and Medicine, 1985, East West Press, N. Delhi
4. Sannon R.E, System Simulation: The Art and Science, 1975, Prentice Hall, U.S.A
5. Simulation Modeling and Analysis-Averill M. Law & W. David kelton;Tata McGrawHill (3rd ed.)

TSC 2103 Finite Element Methods (3-0-0-3)

Module I

Integral Formulations and Variational symbol

Initial and Eigen value problems, Integral Relations, Functional, Base Functions, The Variational symbol, Formulation of Boundary value problems. (6L)

Module II

Variational Methods

Variational Methods of approximation-the Rayleigh-Ritz Method, the method of Weighted Residuals(Gelarkin's Method). (10L)

Module III

Finite Element Analysis of one-dimensional Problems: Second-order and fourth-order boundary value problems and their applications in Heat transfer, Fluid Mechanics and Solid Mechanics. Eigen value and Time-dependent problems. (10L)

Module IV

Finite Element Analysis of Two-dimensional Problems:

Second –order equations for one scaler variable (e.g. torsion, heat transfer, solid Mechanics, Fluid mechanics). Interpolation Functions, Numerical Integration and Modelling Considerations, Triangular Elements, Rectangular Elements, The Serendipity Element. (10L)

Books :

1. Energy and variational Methods in Applied mechanics by J.N. Reddy.
2. The Finite Element Method by O.C. Zienkiewicz.
3. Introductory methods of Numerical analysis; S S Sastry, Prentic Hall, INDIA
4. An Introduction to the Finite Element Method; J N Reddy ; McGraw Hill.

Elective II

SAM 3117 ARTIFICIAL NEURAL NETWORK AND FUZZY LOGIC (3-0-0-3)

Module I

Artificial Neural Network

Introduction : Comparing real and artificial neural systems; Simplified neuron, normal artificial neuron, Artificial neural system definition, Brain versus computer processing.

Foundation of artificial neural systems; processing elements, threshold functions, Topology characteristics, Memory recall, Learning, Stability and convergence. Supervised learning and feedback recall ANS, Brain-state in a Box (BSB), Supervised learning and feedforward recall ANS. Perception Adline/Madline, Backpropagation. (12L)

Module II

Artificial Neural System implementation:

Artificial Neural System paradigm and their application and implementations.

Unsupervised learning and feedback recall ANS, Additivs Grosberg, shunting Grosberg, ART1, ART2, Discrete Autocorrelator, Continuous Hopfield, BAM, Radial Basis Network. (8L)

Module III

Unsupervised learning and Feedforward Recall ANS learning Matrix, Linear Associative Matrix, Optimal Linear associative memory, learning vector quantizer, counter propagation. (8L)

Module IV

Fuzzy Logic:

Basic fuzzy set theory, possibility theory, fuzzy logic uncertainty – based information, Approximate reasoning, fuzzy decision making, engineering application of fuzzy sets and logic. (8L)

Books :

1. George J Klir and Bo Yuan (1997), Fuzzy sets and Fuzzy logic, Prentice-Hall of India, N.D.
2. Bose N.K and Liang P. (1998) Neural Network Fundamentals with graph, Algorithm and applications, Tata McGraw Hill Publication company ltd, N.D.
3. Haykin Simon, Neural network, Addison Wesley Longman Pvt. Ltd, Delhi.

SAM 3119 **MECHANICS OF SOLIDS** **(3-0-0-3)**

Module I

Theory of stress, Types of External Forces, The stress tensor, Equations of motion and Equilibrium in terms of the components of the stress tensor, Equation of motion and equilibrium referred to Cartesian, Cylindrical, Polar Coordinate system. (8L)

Module II

Determination of Principal stresses, Strain Compatability equations, Component of the small strain and rotation tensor referred to Cartesian, Cylindrical and Spherical Polar coordinates. (8L)

Module III

Generalized Hook's law, Various cases of Elastic Symmetry of body, Complete system of fundamental equation in the theory of elasticity, Simple problems of the theory of elasticity, The plain problem in the theory of elasticity.

Airy's stress function, Torson and Bending of Prismatic bodies,Two-dimensional problems in Elasticity.

Application of Complex Variables to the Two dimensional problems of Elasticity. (10L)

Module IV

Interior of the earth, Wave Motion, The body waves, Surface Waves, Propagation of elastic waves in different media, Love waves and Reyliegh Waves. Torsion and flexure of Beams, Bending of a circular pipe.

Variational methods, Theorem of minimum Potential energy, Theorem of minimum Complementry energy, Theorem of Work and Reciprocity. (10L)

Books:

1. Theory of Elasticity by Stephen Timoshenko, McGraw-Hill Companies; 3 edition (June 1970), 608 pages.

*The Linearized Theory of Elasticity, **Slaughter**, William S., 2002, XVI, 543 p., 36 Illus.*

2. S. Timoshenko and J.N. Goodier, Theory of Elasticity, McGraw-Hill, Inc., New York. 1951.
3. I.S. Sokolonikoff, The mathematical theory of Elasticity, McGraw-Hill, New York,. 1956.

SAM 3121 **Boundary Layer Theory** **(3-0-0-3)**

Module I

Difference between real and perfect fluid. Derivation of Navier Stokes equations interpreted as vorticity transport equation. Equations of motion for viscous fluid, similarity of flows, Reynolds number**.** (6L)

Module II

Exact equation: Flow between parallel flat plates. Hager Poisseuille theory of steady flow in pipes. Flow between two concentric cylinders, stragnation in plane flow, flow near a rotatiog disc. Stokes first and second problems. Application of parallel flow theory, Unsteady flow over a flat plate. (8L)

Module III

Boundary layer concept, Boundary layer equations in two-dimensional flow, Boundary layer flow along the flat plates: Blasius solution. Shearing stress, momentumloss thickness, Boundary layer thickness and skin friction. Exact solution of the steady state boundary layer equations in two-dimensional motion. Flow past a wedge. Flow in a convergent channel. (10L)

Module IV

Boundary layer on a surface with pressure gradient, Momentum integral theorems for Boundary layer, The Von Karman integral relation, Application of Momentum integral equation to Boundary layers: Von Karman-Pohlhansen method, Separation of boundary layer flow, Boundary layer control, Methods of Boundary layer control, Introduction to turbulent flow: Origin of turbulence, Reynold's modification of Navier- Stoke's equations for turbulent flow, Semi-emperical theory of turbulence 12L)

Books:

1. Boundary Layer Theory: H. Sclichting, McGraw Hill Comp.
2. Laminar Boundary Layer : L. Rosenhead, Dover Pub.
3. Fluid Mechanics [Si Units]: Cengel, Tata McGraw-Hill Education

SAM 3001 COMPUTATIONAL FLUID DYNAMICS (3-0-0-3)

Module I

Introduction: Computational Fluid Dynamics; Classification of Partial Differential Equation's; Linear and Non-linear Partial Differential Equation's; Model equations, Elliptic, parabolic and hyperbolic equation; System of 1st order Partial Differential Equation's; System of 2nd order Partial Difference Equation; Initial Conditions; Boundary Conditions. (6L)

Module II

Finite Difference Formulations: Introduction; Taylor Series Expansion; Finite Difference by Polynomial; Finite Difference Equations; Higher order derivatives; Multidimensional finite difference formulas; Applications, Finite Difference Approximation of Mixed Partial Derivatives; Stability Analysis: Discrete Perturbation Stability Analysis; Von Neumann Stability Analysis; Multidimensional problem; Error Analysis; Artificial Viscosity; (8L)

Module III

Solution Methods of Finite Difference Equations

Elliptic equations : Finite difference formulations, Jacobi Iteration Method, Point Gauss Seidel Iteration Method, Line Gauss Seidel Iteration Method, Point Successive Over Relaxation Method Point Successive Over Relaxation Method, Alternating Direction Implicit Method, Applications.

Parabolic equation: Finite difference formulations, Explicit schemes, implicit schemes, Alternating Direction Implicit Schemes, Parabolic equations in two-space dimensions, Approximate factorization, Fractional Step methods.

Hyperbolic equations: Explicit and Implicit schemes, Splitting method, Multistep methods, Application to Linear Problem, Non-linear problems, Flux corrected Transport, Classification of Numerical Scheme, TVD formulations.

Example problems : Heat conduction, Couette flow, Wave equation. (8L)

Module IV

Incompressible Navier-Stokes Equations

Introduction; Primitive variable and Vorticity Stream Function formulations; Poisson equations for pressure (Primitive variable and Vorticity Stream Function formulation); Numerical algorithm (Primitive Variable);

Artificial Compressibility

Solution on a Regular Grid; Crank Nicolson Implicit; Boundary conditions (Body Surface, Far Field, Symmetry, Inflow Outflow); Staggered grid; Marker and Cell Method;

Implementation of Boundary Condition; DuFort Frankel Scheme; Use of the Poisson Equation for Pressure; (8L)

Module V

Unsteady Incompressible Navier-Strokes Equation.

Euler Equation; Explicit Formulations(Steger and Warming Flux Vector Splitting,Van Leer Flux Vector Splitting, Runge Kutta formulation, T/D formulation); Implicit formulations (steger and Warming Flux Vector Splitting); Boundary conditions; Global Time Step and Local Time Step;

Example problem (Diverging nozzle configuration, Shock tube or Reimann problem, supersonic channel flow). (6L)

BOOKS

1. Computational Fluid Dynamics (Vol. I & II): K. A. Hoffmann and S. T. Chinag
2. Numerical Computational of Internal and External Flows:
3. Volume 1: Fundamentals of Numerical Discretisation: Charles Hirsch
4. Volume 2: Computational Methods for Inviscid and Viscous Flows : Charles Hirsch
5. Computational Methods of Fluid Dynamics : J. H. Ferziger & M. Peric
6. An Introduction to Theoretical and Computational Aerodynamics : - Jack Moran
7. Numerical Grid Generation : - Thompson, Warsi and Mastin
8. Computational Fluid Dynamics : - Patrick J. Roache
9. Computational Methods of Fluid Dynamics (Vol I & II) : - C. A. J. Fletcher.
10. Fundamentals of CFD :- Lomax, Pulliam and Zingg.
11. Numerical Heat Transfer and Fluid Flow : - S. V. Patankar.
12. Computational Fluid Dynamics : - Anderson, John D., Jr.