Course Structure and Syllabus
for
Two Year M. Sc. Programme in Applied Mathematics

First Semester

Course Code	Title of the Course	Core/Elec.	L-T-P	Internal	External Exam.	Total Marks
AM-101	Linear Algebra	C	3-1-0	30	70	100
AM-102	Real Analysis	C	3-1-0	30	70	100
AM-103	Ordinary Differential Equations	C	3-1-0	30	70	100
AM-104	Methods of Applied Mathematics-I	C	3-1-0	30	70	100
AM-105	Computer Programming	C	3-1-1	30	70	100

Second Semester

Course Code	Title of the Course	Core/Elec.	No. of credit	Internal	External Exam.	Total Marks
AM-201	Abstract Algebra	C	3-1-0	30	70	100
AM-202	Complex Analysis	C	3-1-0	30	70	100
AM-203	Applied Numerical Methods	C	3-0-1	30	70	100
AM-204	Partial Differential Equation	C	3-1-0	30	70	100
AM-205	Probability and Statistics	C	3-1-0	30	70	100

Third Semester

Course Code	Title of the Course	Core/Elective	No. of credit	Internal	External Exam.	Total Marks
AM-301	Methods of Applied Mathematics-II	C	3-1-0	30	70	100
AM-302	Operation Research	C	3-1-0	30	70	100
AM-303	Functional Analysis	C	3-1-0	30	70	100
AM-304	Mechanics	C	3-1-0	30	70	100
AM-305(A)	Elective - I	E	3-1-0	30	70	100

Fourth Semester

Course Code	Title of the Course	Core/ Elective	No. of credit	Internal	External Exam.	Total Marks
AM-401	Fluid Dynamics	C	3-1-0	30	70	100
AM-402	Applied Discrete Mathematics	C	3-1-0	30	70	100
AM-403	Elective - II	E	3-1-0	30	70	100
AM-404	Elective – III	E	5-0-0	30	70	100
AM-405	Seminar and Project	C	0-3-1	30	70	100

secA 10ques 3 mark each// secB &C 2ques 10 mark each

AM-101 LINEAR ALGEBRA

UNIT-I: Vector space, Subspace, Direct sum and Linear independence of subspaces, Linear independence and the Span, Bases and dimension.

UNIT-II: Linear Transformation. Range and Null Space of linear transformation, Matrix representation of linear transformation, Inverse linear transformation, Change of basis matrix.

UNIT-III: Eigen Values and Eigen vectors, Cayley- Hamilton Theorem, Diagonalization, Geometric and algebraic Multiplicity.

UNIT-IV: Inner products, orthonormal sets, Gram-Schmidt orthogonalization, Bessel's inequality, orthonormal basis linear functional, dual space and Adjoint operator, Hermitian matrix, Normal Matrices, Bilinear form, Quadratic from.

Text and Reference Books:

1. Linda Gilbert and Jimmie Gilbert, Elements of Modern Algebra, Seventh edition, Cengage Learning.
2. Herstein, I. N., "Topics in Algebra", 2nd Ed., John Wiley & Sons. 2004
3. Fraleigh, J. B., "A First Course in Abstract Algebra", 7th Ed., Pearson Education 2003
4. Artin M., "Algebra", 2nd Ed., Prentice Hall India 2011
5. Gallian J. A., "Contemporary Abstract Algebra", 8th Ed., Cengage Learning 2013
6. Hoffman, K. and Kunze, R., "Linear Algebra",Pearson Education (Asia) Pvt. Ltd/ Prentice Hall of India 2004
7. Leon, S.J., "Linear Algebra with Applications", 8th Edition, Pearson 2009
8.. Peter, J. Olever and Shakiban, C., "Applied Linear Algebra", 1 Edition, Prentice Hall 2005
9. Strang, G., "Linear Algebra and its Applications",Thomson Learning Asia Pvt Ltd 2003

AM-102 REAL ANALYSIS

UNIT-I: Function and limits, Sequence and series, limsup, liminf, continuity, differentiability of functions of one variables, Definition of integral, Existence of integral, Properties of Integral, Riemann integral, Improper Integral.

UNIT-II: Sequence and series of Functions: Pointwise and Uniform Convergence, Cauchy Criterion for uniform convergence, Weierstrass M-test, Uniform convergence and continuity, , Uniform convergence and integration, Uniform convergence and differentiation, Riemann-Stieitjes integral.

UNIT-III: Functions of several variables: continuity and Differentiation of vector-valued functions, linear transformation of R^n, properties and invariability, inverse and implicit function theorems.

UNIT-IV: Directional Derivative, Chain rule, Partial derivative, Hessian matrix. The Inverse Functions Theorem and its illustrations with examples. The Implicit Function Theorem, illustration, and examples.

Text and Reference Books:

1. Royden. H.L. and Fitzpatrick. P.M., Real Analysis,Prentice Hall India Pvt. Ltd.2010
2. Apostol, T. M., Mathematical Analysis, Narosa Publishing House. 2002
3. Lang. S., Real and Functional Analysis, Springer-Verlag. 1993
4. Rudin. W., Principles of Mathematical Analysis, McGraw-Hill Book Company.1976
5. Goldberg, R.R., Methods of Real Analysis, Oxford and IBH Publishing company Pvt. Ltd. 1970
4. J. Dieudonne: Treatise on Analysis, Vol. I, Academic Press, 1960.

AM-103 ORDINARY DIFFERENTIAL EQUATION

UNIT-I: Linear differential equations of n^{th} order, theorems on linear dependence of solutions, the n^{th} order non-homogeneous linear equations, Variation of parameters,

UNIT-II: Fundamental existence and uniqueness theorem. Dependence of solutions, Properties of Wronskian, existence and uniqueness theorem for higher order and system of differential equations.

UNIT-III: Eigenvalue problems, Sturm-Liouville problems, Orthogonality of Eigen functions, Eigen function expansion in a series of orthonormal functions. Matrix method for linear system of homogeneous and non-homogeneous equations, Green functions.

UNIT-IV: Power series solution of linear differential equations, Series solution about an ordinary point and a regular singular point, Frobenius method, Bessel's, Legendre's, Generating function, Recurrence relations, Rodrigue's formula, Orthogonality properties.

Text and Reference Books:

1 Simmons, G. F. , "Differential Equations " , McGraw-Hill, 2nd Edition 1991
2. M.S.P. Eastham : Theory of ordinary differential equations, Van Nostrand, London, 1970.
3. S.L.. Ross: Differential equations, John Wiley & Sons, NewYork.
4. E.D. Rainville and P.E. Bedient : Elementary Differential Equations, McGraw Hill, NewYork, 1969.
5. E.A. Coddington and N. Levinson : Theory of ordinary differential equations, McGraw Hill, 1955.
6.. A.C.King, J.Billingham and S.R.Otto: 'Differential equations', Cambridge University Press, 2006.
7. Hildebrand F. B., "Methods of Applied Mathematics", Courier Dover Publications 1992
8. Tenenbaum, M. and Polard, H., "Ordinary Differential Equations", Dover Publications

AM-104 METHODS OF APPLIED MATHEMATICS-I

Unit-I: Laplace Transform: Laplace of some standard functions, Existence conditions for the Laplace Transform, Shifting theorems, Laplace transform of derivatives and integrals, Inverse Laplace transform and their properties, Convolution theorem, Initial and final value theorem, Laplace transform of periodic functions, error functions, Heaviside unit step function and Dirac delta function, Applications of Laplace transform to solve ODEs and PDEs.

Unit-II: Hankel Transform: Basic properties of Hankel Transform, Hankel Transform of derivatives, Application of Hankel transform to PDE.
Mellin Transform: Definition and properties of Mellin transform, Shifting and scaling properties, Mellin transforms of derivatives and integrals, Applications of Mellin transform.

Unit-III: Fourier series: Trigonometric Fourier series and its convergence. Fourier series of even and odd functions, Gibbs phenomenon, Fourier half-range series, Parseval`s identity, Complex form of Fourier series.

Unit-IV: Fourier Transforms: Fourier integrals, Fourier sine and cosine integrals, Complex form of Fourier integral representation, Fourier transform, Fourier transform of derivatives and integrals, Fourier sine and cosine transforms and their properties, Convolution theorem, Application of Fourier transforms to Boundary Value Problems.

Text and Reference Books:

1. Kreyszig, E., "Advanced Engineering Mathematics", John Wiley & Sons 2011
2. Jain, R. K. and Iyenger, S. R. K., "Advanced Engineering Mathematics", Narosa Publishing House 2009
3. Hildebrand F. B., "Methods of Applied Mathematics", Courier Dover Publications 1992
4. Debanth L. and Bhatta D., Integal Tranforms and Their Applications, 2nd edition, Taylor and Francis Group.

AM-105 COMPUTER PROGRAMMING

UNIT-I: Introduction to flow charts and algorithm, Data types, Operators and Some statements: Identifiers and key words, Constants, C operators, Type conversion. Writing a Program in C: Variable declaration, Statements, Simple C Programs, input and output statement.

UNIT-II: Control statements: Conditional expressions: If statement, if-else statement, Switch statement, Loop statements: For loop, while loop, Do – while loop, breaking control. Statements: Break statement, Continue statement, goto statement. Functions and Program Structures: Introduction, Defining a function, return statement.

UNIT-III: Types of Functions, Actual and formal arguments, Local Global variables. The scope of variables: Automatic Variables, Register Variables, Static Variables, External Variables, Recursive functions.

UNIT-IV: Introduction to Arrays, Arrays and functions, Multidimensional array, Character array. Pointers: Pointer declaration, Pointer operator, Address Operator, Pointer expressions, Pointer arithmetic, Pointers and functions, Call by value, Call by reference, dynamic memory allocation.

Text and Reference books:

1. D.Ravichandran, Programming in C, New Age International, 1998
2. E. Balagurusami, Programming in ANSI, Multicolour Edition, Sixth Edition.

AM-201 ABSTRACT ALGEBRA

UNIT-I : Definition of Group, Properties of group, Subgroup, Cyclic group, , Permutation group, Cayley theorem.

UNIT-II: Normal Subgroup, Quotient group, Isomorphism, Homomorphism Direct Product, Finte Abelian Group.

UNIT- III RINGS Definition of a Ring - Formal Construction of Integers and Polynomials -Homomorphism and Ideals - Quotient Rings and Relations in a Ring - Adjunction of Elements - Integral Domains and Fraction Fields - Maximal Ideals.

UNIT -IV FACTORIZATION: Factorization of Integers and Polynomials - Unique Factorization Domains, Principal Ideal Domains, and Euclidean Domains - Gauss's Lemma - Explicit Factorization of Polynomials - Primes in the Ring of Gauss Integers - Algebraic Integers

Text and Reference Books

1. Artin M., "Algebra", Prentice - Hall, New Jersey, 1991.
2.. I.N Herstein, "Topics in Algebra", 2nd Edition, Wiley, New York, 1975.
3. N. Jacobson," Basic Algebra", Vol.1 & 2, W.H. Freeman and Company, 1985, 1980.
4. S. Lang, "Algebra" 3rd Edition, Pearson Education, 1993.
5. Fraleigh J. B., "A first course in Abstract Algebra", Narosa, 1990.

AM-202 COMPLEX ANALYSIS

UNIT-I: Analytic functions, Harmonic conjugates, Elementary functions, Mobius Transformation, Conformal mappings, Cauchy's Theorem and Integral formula, Morera's Theorem, Zeros of Analytic function. The index of a closed curve, counting of zeros, Liouville's Theorem, Fundaments theorem of algebra.

UNIT-II: Series, Uniform convergence, Power series, Radius of convergence, Power series representation of Analytic function, Taylor's series, Laurent's series.

UNIT-III: Rational Functions, Singularities, Poles, Classification of Singularities, Characterization of removable Singularities. Behavior of an Analytic functions at an essential singular point. Entire and Meromorphic functions.

UNIT-IV: The Residue Theorem, Evaluation of Definite integrals, Argument principle, Rouche's Theorem, Schwartz lemma, Open mapping and Maximum modulus theorem and applications.

Text and Reference Books:

1. J. B. Conway : Functions of one complex variable, Narosa, 1987.
2. L.V. Ahlfors : Complex Analysis, McGraw Hill, 1986.
3. R. Nevanlinna : Analystic functions, Springer, 1970.
4. E. Hille : Analytic Teory, Vol. I, Ginn, 1959.
5. S. Ponnaswamy : Functions of Complex variable, Narosa Publications
6. Churchill, J. W. and Brown, R. V., "Complex Analysis", Mcgraw Hill.2009
7. Gamelin, T. W., "Complex Analysis", Springer-Verlag 2001

AM-203 APPLIED NUMERICAL METHODS

Unit-I: Transcendental and polynomial equations: Bisection method, Iteration methods based on first degree equation; Secant method, Regula-falsi method, Newton-Raphson method, Generalized Newtons method, Rate of convergence.

Unit -II: System of linear equation: Direct methods, Guass elimination method, Triangularization method, Iteration method: Jacobi Method, Gauss seidel Iterative method, SOR method, Givens and Power methods for Eigen values Eigen vectors.

Unit-III: Lagrange and Newton's divided difference interpolation, Finite difference operators, sterling and Bessel interpolation, Hermite interpolation, piecewise and Spline Interpolation, least square approximation, Numerical Differentiation: methods based on Interpolation, methods based on Finite difference operators, Numerical Integration: methods based on Interpolation, Newton's cotes methods, methods based on Undertermined coefficients, Guass, Legendre, Integration method.

UNIT-IV: Numerical methods for ODE: Single step methods: Eulers method, Taylor series method, Runge kutte second and forth order methods, Numerical methods for boundary value problems.

Text and Reference Books:

1. Gerald, C. F. and Wheatly, P. O.," Applied Numerical Analysis", 6th Edition, Wesley. 2002
2. Jain, M. K., Iyengar, S. R. K. and Jain, R. K., "Numerical Methods for Scientific and Engineering Computation", New Age Pvt. Pub, New Delhi. 2000
3. Conte, S. D. and DeBoor, C., "Elementary Numerical Analysis", McGraw-Hill Publisher
4. Krishnamurthy, E. V. & Sen, S. K., "Applied Numerical Analysis", East West Publication.
5. Introduction to Numerical Analysis, by S.S. SastryPrentice Hall Flied.

AM-204 PARTIAL DIFFERENTIAL EQUATION

UNIT-I: Formation of partial differential equations, Solution of partial differential equations of first order, Integral surface passing through a given curve, Surface orthogonal to a given system of surfaces.

Unit-II: First order non-linear partial differential equations, Cauchy Method of Characteristics, compatible system of first order equations, Charpit's method, Special types of First order partial differential equations.

UNIT-III: Second order PDE with Constant Coefficients, Classification of second order partial differential equations, Canonical form, Canonical form for hyperbolic, parabolic and elliptic equation.

UNIT-VI: Solution of PDE by the method of separation of variables, Solution of one and two dimension Wave equation, Heat equation and Laplace equation. Monge's Methods, Green functions.

Text and Reference Books:

1. I. N. Sneddon, Elements of PDE's , McGraw Hill Book company Inc., 2006.
2. L Debnath, Nonlinear PDE's for Scientists and Engineers, Birkhauser, Boston, 2007.
3. F. John, Partial differential equations, Springer, 1971.
4. F. Treves: Basic linear partial differential equations, Academic Press, 1975.
5. M.G. Smith: Introduction to the theory of partial differential equations, Van Nostrand.
6.K Shankar Rao:Introduction to Partial Differential Equations, PHI, 2006.

AM-205 PROBABILITY AND STATISTICS

UNIT-I: Probability: Axiomatic definition, Properties. Conditional probability, Bayes rule and independence of events, Random variables, Distribution function, Probability mass and density functions, Expectation, Moments, Moment generating function.

UNIT-II: Probability distributions: Binomial, Geometric, Negative -Binomial, Poisson, Uniform, Exponential, Gamma, Normal distributions, Moments Independence of random variables, Covariance, Correlation, Functions of random variables.

UNIT-III: Statistics: Population, Sample, Parameters. Method of moment, Unbiasedness, Confidence interval, estimation for mean, difference of means, variance, proportions, Sample size problem,

UNIT-IV: Test of Hypotheses: Tests for means, variance, two sample problems, Test for proportions, Relation between confidence intervals and tests of hypotheses, Chi-square goodness of fit tests, Contingency tables.

Text and Reference Books:

1. S.C. Gupta and V.K. Kapoor, "Fundamentals of Mathematical Statistics" Sultan Chand &Sons New Delhi.
2. Hogg, R. V. and Craig, A., "Introduction to Mathematical Statistics", Pearson Education.
3. Rohatgi, V. K. and Md. Ehsanes Saleh, A. K., "An Introduction to Probability and Statistics", John Wiley and Sons, 2nd edition.2000
4. Papoulis, A., Pillai, S.U., Probability, "Random Variables and Stochastic Processes", Tata McGraw-Hill, 4th Ed. 2002
5. Bhatt B.R., "Modern Probability Theory", New Age International Ltd,1999

AM- 301 Methods of Applied Mathematics-II

UNIT-I Introduction to variational problem, problem of brachistochrone, problem of geodesics, isoperimetric problem, Variational problems with the fixed boundaries, Euler's equation, the fundamental lemma of the calculus of variations, Functionals in the form of integrals.

UNIT-II: Functionals involving more than one dependent variables, the system of Euler's equations, Functionals depending on the higher derivatives of the dependent variables, Euler- Poisson equation, Functionals containing several independent variables, Ostrogradsky equation, Variational problems in parametric form, Variational problems with moving boundaries, applications to differential equations.

Unit-III: Integral equations: Basic concepts, solutions of integral equations, Relations between differential and integral equations, Solutions of Voltera's and Fredholm's integral equations, Integral equations with separable kernels, Hilbert-Schmidt theory.

Unit-IV: Methods to Solve Integral Equations, Iterative methods for solving equations of the second kind, The Neumann series, Fredholm theory, Singular Integral Equations. Approximations to characteristic functions, Approximations of Fredholm and Volterra equations by sets of algebraic equations.

Text and Reference Books:

1. Gupta A.S., "Calculus of Variations with Applications" Prentice Hall of India
2. Elsgolts L., "Differential equations and the Calculus of Variations", MIR Publishers, 1980.
3. Hildebrand F. B.: Methods of Applied Mathematics, Prentice Hall Inc., 2nd Edition, 1965.
4. Kanwal R.P.: Generalized Functions: Theory and Techniques, Academic Press, New York.
5. Lovitt W. V.: Linear Integral Equation, Dover Pub., 1st Ed., 1950
6. Mikhlin S.G.: Linear Integral Equation (translated from Russian), Hindustan Book Agency, 1960.

AM-302 Operation Research

Unit-1: Introduction: Origin of OR and its definition. Types of OR problems, Phases of OR problem approach, problem formulation, building mathematical model, Formulation of Linear Programming Problems , Graphical solution of Linear Programming.

Unit-II: Solution of LPP by Simplex Method, Two phase method, Big-M method, Methods to resolve degeneracy in Linear Programming problem, Revised Simplex Methods and applications.

Unit-III: Concept of Duality in Linear Programming, Comparison of solutions of the Dual and its primal. Dual Simplex Methods, Sensitivity Analysis, Integer Programming.

Unit-IV: Mathematical formulation of Transportation problem, Tabular representation, Methods to find initial basic feasible solution, Optimality test, Method of finding optimal solution, Degeneracy in transportation problem, Unbalanced transportation problem, Mathematical formulation of Assignment problem, Hungarian Assignment Method,

Text and Reference Books:

1. Beale, E. M. L. and Mackley, L.: *"Introduction to Optimization"*, John Wiley, 1988
2. Hiller, F. S. and Lieberman: *"Introduction to Operations Research", 6th Ed.*, McGraw-Hill International Edition, Industrial Engineering Series, 1995.
3. Rao, S.S.: "*Optimization Theory and Applications*", *2nd Ed.*, Willey Eastern Ltd., New Delhi, 1985.
4. Taha, H. A., *"Operations Research: An Introduction", 8th Ed.*, Prentice Hall Publishers.
5. Sharma, S.D., " Operations Research" Kedar Nath Ram Nath and Co. Meerut,2002.
6. Swarup Kanti, Gupta P.K. and Man Mohan, :" Operations Research" Sultan Chand and Sons, New Delhi, 2005.
7. Gupta, Prem Kumar, Hira, D.S.: " Operations Research" S.Chand & Company Pvt. Ltd

AM-303 FUNCTIONAL ANALYSIS

Unit-I: Metric space, pseudo metric, open and closed sphere, limit and continuity, sequences, cantor intersection theorem, Bair category theorem, fixed point theorem.

Unit-II: Normed Linear Spaces, Fixed point theorem, Riesz lemma, finite dimensional spaces. Bounded linear maps on normed linear spaces, linear maps on finite dimensional spaces, operator norm, Banach Spaces, Hahn-Banach theorems and its applications. Open mapping and Closed graph theorems, Uniform boundedness Principle, divergence of Fourier series.

Unit-III: Dual spaces and adjoint of an operator: Duals of classical spaces, weak and weak convergence, adjoint of an operator, Hilbert spaces: Inner product spaces,, Separable Hilbert spaces, projection and Riesz reprentation theorem.

Unit-IV: Bounded operators on Hilbert space: Adjoint operator, normal, unitary, self-adjoint operator, compact operator, eigen value , eigen vectors, Banach algebras, Spectral theorem: Spectral theorem for compact self adjoint operators, spectral theorem for bounded self adjoint operators. Self adjoint, normal and unitary operators;

Text and Reference Books:

1. Conway J.B.: *A course in Functional Analysis*, Springer-Verlag, New York, 1990.
2. Goffman C. and Pedrick G.: *First course in in functional analysis*, Prentice Hall of India, New Delhi, 1987.
3. Simmons G.F.: *Topology and Modern Analysis*, Mc Graw-Hill, New York, 1963.
4. Taylor A.E.: *Introduction to Functional Analysis*, John Wiley & sons, New York, 1958.
5. W. Rudin: *Functional Analysis*, Mc Graw-Hill, New York, 1991.

AM – 304 MECHANICS

UNIT-I Lagrangian Formulation: Mechanics of a particle, mechanics of a system of particles, constraints, generalized coordinates, generalized velocity, generalized force and potential. D'Alembert's principle and Lagranges equations, some applications of Lagrangian formulation,

UNIT-II Hamilton's principle, derivation of Lagrange's equations from Hamilton's principle, extension of Hamilton's principle to non-holonomic systems.

UNIT-III Hamiltonian formulation: Legendre transformations and the Hamilton equations of motion, cyclic coordinates and conservation theorems, derivation of Hamilton's equations from a variational principle, the principle of least action, the equation of canonical transformation.

UNIT-IV Poisson and Lagrange brackets and their invariance under canonical transformation. Jacobi's identity; Poisson's Theorem. Equations of motion infinitesimal canonical transformation in the poisson bracket. Hamilton Jacobi Equations for Hamilton's principal function, The harmonic oscillator problem as an example of the Hamilton – Jacobi method.

Text and Reference Books:

1. Classical mechanics by H.Goldstein, 2nd edition, Narosa Publishing House.
2. Relevant topics from Special relativity by W.Rindler, Oliver & Boyd, 1960.

AM -401 FLUID DYNAMICS

Unit-I: Introduction to fluid dynamics, Normal and Shear stress, Different types of flows, Lagrangian and Eulerian description of fluid motion, Stream lines and path lines, Vorticity equation, Vortex sheets, filaments. Equation of continuity in cartesian and general vector form, Expression in cylindrical and spherical coordinates, Euler's equation of motion in general vector form, Bernoulli's equation.

Unit-II: Navier Stokes equations : General theory of stress and rate of strain in fluid flow. Nature of stresses. Stress analysis in fluid motion, Nature of strains. Relation between stress and rate of strain. Derivation of the Navier-stokes equations. Derivation of Euler's equations as a special case of Navier – Stokes equation, Reynold's number. .

Unit-III: Nature of Magneto hydrodynamics, Maxwell's electromagnetic field equations, Equation of motion of conducting fluid, rate of flow of charge, Magnetic Reynold's number, Alfven's Theorems, Ferraro's laws of isolation.

Unit-IV: Gas Dynamics: speed of sound, Equation of Motion, subsonic, sonic, supersonic flows, isentropic gas flow, Reservoir discharge through a channel of varying cross sections, shock waves, formation, elementary analysis of normal shock wave.

Text and Reference Books:

1. Bachelor G.K.: *An introduction to fluid dynamics*, Publisher, Cambridge University Press,2000.
2. Hermann Schlichting, Klaus Gersten, Krause E., Jr. Oertel H., Mayes C.: *"Boundary-Layer Theory"* , 8th edition Springer 2004
3. Kundu, Pijush K., and Cohen Ira M.: Fluid Mechanics. 3rd ed. Burlington, MA: Elsevier, 2004.
4. O'Neill M. E. and Chorlton F.: *Ideal and Incompressible fluid dynamics*, Publisher: John Wiley & Sons, 1986.
5. Yuan S. W.: *Foundations of fluid Mechanics*, Publisher: Prentice – Hall International, 1970.

AM-402 APPLIED DISCRETE MATHEMATICS

UNIT-I: Logic: Introduction to logic, Rules of Inference, Validity of Arguments, Normal forms. Directs, Indirect proofs, Proof by contradiction, Proof by cases, etc.

UNIT-II: Recurrence relations with examples of Fibonacci numbers, the tower of Hanoi problem, solving recurrence relations. Generating functions, definition with examples, solving recurrence relations using generating functions, Difference equations.

UNIT-III: Definition and types of relations. Representing relations using matrices and digraphs, Closures of relations, Paths in digraphs, Transitive closures, Warshall's Algorithm. Order relations, Posets, Hasse diagrams, Lattices.

UNIT-IV Boolean algebra and Boolean functions, different representations of Boolean functions, application of Boolean functions to synthesis of circuits, circuit minimization and simplification, Karnaugh map.

Text and Reference Books:

1. C. L. Liu: Elements of Discrete Mathematics, Tata McGraw-Hill, 2000.
2. Kenneth Rosen, WCB McGraw-Hill,6th edition, 2004.
3. J.P. Tremblay and R.P. Manohar : Discrete Mathematical Structures with applications to computer science, McGraw Hill (1975).
4. F. Harary: Graph Theory, Addition Wesley, 1969.

Elective –I (One of the following is to be chosen)

1. **AM- 305 (A) Optimization Techniques-I**
2. **AM- 305 (B) Finite Element Methods**
3. **AM-305 (C) Graph Theory**

AM -305(A) OPTIMIZATION TECHNIQUES-I

Unit-I: Theory of Games: Introduction, Saddle Point, Minimax-Maximin Criteria for Optimal Strategy, Minimax Theorem, Solution of Games by LPP, Arithmetic Methods, Principle of Dominance, Graphical Methods, Matrix Methods and Iterative Methods.

Unit-II: Network Analysis: Basic steps, Network diagram representation, Rules for drawing networks, Forward pass and Backward pass computations, Determination of floats, Determination of critical path, Project evaluation and review techniques updating. Application areas of PERT/CPM Techniques.

Unit-III: Job Sequencing, Principle Assumption, Solution of Sequencing problem, n-jobs through 2-Machines, n- Jobs through 3- Machines, 2- jobs through m- machines, n-jobs through m- machines.

Unit-IV: Introduction Functions of inventory and its disadvantages, ABC analysis, Concept of inventory costs, Basics of inventory policy (order, lead time, types), Fixed order-quantity models – EOQ, POQ & Quantity discount models. EOQ models for discrete units, Special cases of EOQ models for safety stock with known/unknown stock out situations.

Text and Reference Books:

1. Beale, E. M. L. and Mackley, L.: *"Introduction to Optimization"*, John Wiley, 1988
2. Hiller, F. S. and Lieberman: *"Introduction to Operations Research", 6th Ed.*, McGraw-Hill International Edition, Industrial Engineering Series, 1995.
3. Rao, S.S.: *"Optimization Theory and Applications", 2nd Ed.*, Willey Eastern Ltd., New Delhi, 1985.
4. Taha, H. A., *"Operations Research: An Introduction", 8th Ed.*, Prentice Hall Publishers.
5. Sharma, S.D., " Operations Research" Kedar Nath Ram Nath and Co. Meerut,2002.
6. Swarup Kanti, Gupta P.K. and Man Mohan, :" Operations Research" Sultan Chand and Sons, New Delhi, 2005.
7. Gupta, Prem Kumar, Hira, D.S.: " Operations Research" S.Chand & Company Pvt. Ltd.

AM-305 (B): FINITE ELEMENT METHODS

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

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

Unit-III: Finite Element Procedures:- Finite Element Formulations for the solutions of ordinary and partial differential equations: Calculation of element matrices, assembly and solution of linear equations.

Unit-IV: Finite Element solution of one dimensional ordinary differential equations, Laplace and Poisson equations over rectangular and nonrectangular and curved domains.

Text and Reference Books:

1. O.C. Zienkiewiez and K. Morgan : Finite Elements and approximation, John Wieley, 1983
2. P.E. Lewis and J.P. Ward : The Finite element method- Principles and applications, Addison Weley, 1991
3. L.J. Segerlind : Applied finite element analysis (2nd Edition), John Wiley, 1984
4. J.N. Reddy: An introduction to finite element method, New York, Mc.Graw Hill, 1984.
5. D.W. Pepper and J.C. Heinrich : The finite element method, Basic concepts and applications, Hemisphere, Publishing Corporation, Washington, 1992.
6. S.S. Rao : The finite element method in Engineering, 2nd Edition, Oxford, Pergamon Press, 1989.
7. D. V. Hutton, fundamental of Finite Element Analysis, (2004).

AM-305 (C) Graph Theory

UNIT-I: Introduction to graphs, Introduction to algorithmic complexity, Introduction to data structures and depth First searching, Adjacency matrices and Adjacency lists, Depth first searching Spanning trees and branching Optimum weight spanning trees, Optimum branching, enumeration of spanning-trees. Circuits, Cut-sets, and Connectivity Fundamental of circuits of graphs, Fundamental cut, Sets of a graph, Connectivity.

UNIT-II: Basic properties of planar graphs, crossing-number and thickness Characterizations of planarity, Dual Graphs Planarity testing algorithm, Networks and flows, Maximizing the flow in a network, Minimum cost flow algorithm.

UNIT-III: Matching, Maximum matching, Perfect Matching, Maximum-Weight matching, Eulerian paths and circuits, Eulerian graphs, Finding Eulerian circuits. Postman problems, Counting Eulerian circuits, Chinese postman problem for undirected graphs, Chinese postman problem for digraphs, Hamiltonian tours some elementary existence theorems, Finding all Hamiltonian tours by martial products, Traveling salesman problem.

UNIT-IV: Graph Coloring, Dominating sets, independence cliques, Coloring graphs Edge Coloring, Vertex Coloring, Chromatic polynomials, Face coloring of embedded graphs, Five colour theorem, Four colour theorem.

Text and Reference Books:

1. Gibbon. A., "Algorithmic Graph Theory", Cambridge University Press, 1985.
2.. Douglas B. West, "Introduction to Graph Theory", Prentice Hall of India, 2002.

Elective –II (One of the following is to be chosen)

1. **AM- 403 (A) Optimization Techniques-II**
2. **AM- 403 (B) Mathematical Modeling and Simulation**
3. **AM-403 (C) Wavelet Analysis**

AM-403 (A) OPTIMIZATION TECHNIQUES-II

Unit-I: Replacement Models: Replacement of items whose maintenance and repair costs increase with time- ignoring changes in the value of money during the period and considering value of money changes with time, replacement of items that fail suddenly, group replacement policy, mortality .

Unit-II: Queuing Theory: Definition of queue (waiting line), waiting costs, characteristics (arrival, queue, service discipline) of queuing system, queue types (channel vs. phase), Kendall's notation, Little's law, steady state behavior, Poisson's Process & queue, Models with examples - M/M/1 and its performance measures; M/M/m and its performance measures; brief about some special models.

Unit-III: Non-Linear Programming: Introduction to nonlinear programming, Convex function and its generalization, Unconstraint and constraint optimization, KKT necessary and sufficient conditions for optimality, Linear complementarity problem and Lemke's complementary pivot algorithm, Quadratic programming and algorithm for solving quadratic programming problem, Separable programming, Linear fractional programming.

Unit-IV: Dynamic Programming and its Applications: Introduction, Nature of dynamic programming, Deterministic processes, Non-Sequential discrete optimization, Allocation problems, Assortment problems, Sequential discrete optimization, Long-term planning problem, Multi-stage decision process, Application of Dynamic Programming in production scheduling and routing problems.

Text and Reference Books:

1. Hiller, F. S. and Lieberman: *"Introduction to Operations Research", 6th Ed.*, McGraw-Hill International Edition, Industrial Engineering Series, 1995.
2. Rao, S.S.: "*Optimization Theory and Applications*", *2nd Ed.*, Willey Eastern Ltd., New Delhi, 1985.
3. Taha, H. A., *"Operations Research: An Introduction", 8th Ed.*, Prentice Hall Publishers.
4. Sharma, S.D., " Operations Research" Kedar Nath Ram Nath and Co. Meerut,2002.
5. Swarup Kanti, Gupta P.K. and Man Mohan, :" Operations Research" Sultan Chand and Sons, New Delhi, 2005.
6. Gupta, Prem Kumar, Hira, D.S.: " Operations Research" S.Chand & Company Pvt. Ltd.

AM-403(B) MATHEMATICAL MODELING AND SIMULATION

UNIT-I: Meaning of first and second order ordinary derivatives, slope of a tangent and curvature. Connecting these concepts to practical observations, Basic concepts. Real world problems, (Physics, Chemistry, Biology, Economics, and others) Approximation of the problem, Steps involved in modeling.

UNIT-II: Mathematical models: Linear growth and decay model, Logistic model, model of Mass-spring-dashpot (present in shock absorbed, mechanical engineering problems), Chemical reaction, Drug absorption from blood stream. Motion of a projectile. Current flow in electrical circuits(LCR), Model for deduction of diabetes.

UNIT-III: Nonlinear system of equation- Combat models- predator- prey equations spread of epidemics, Models leading to linear and nonlinear partial differential equations.

UNIT-IV: Applications of simulation techniques to various problems related to epidemics, ecology, biomechanics etc.

Text and Reference Books:

1. Albright, B., "Mathematical Modeling with Excel", Jones and Bartlett Publishers.2010
2. Marotto, F. R., "Introduction to Mathematical Modeling using Discrete Dynamical Systems", Thomson Brooks/Cole.2006
3. Kapur, J. N., "Mathematical Modeling", New Age International 2005
4. Barnes, B. and Fulford, G. R., "Mathematical Modelling with Case Studies", CRC Press, Taylor and Francis Group. 2009
5. Edsberg, L., "Introduction to Computation and Modeling for Differential Equations", John Wiley and Sons.
6. E. Kreyszig, Advanced Engineering Mathematics, Wileyeastem, 2002.
7. Neil Gerschenfeld : The nature of Mathematical modeling, Cambridge Univeristy Press, 1999.
8. A. C. Fowler : Mathematical Models in Applied Sciences, Cambridge Univeristy Press, 1997.

AM-403(C) WAVELET ANALYSIS

UNIT-I : Rieview of Fourier Analysis, Wavelet Transform and Time Frequency Analysis: The Gabor transform, Short time Fourier transforms and the uncertainty principle.The integral wavelet transform – Diadic Wavelets and inversions – Frames.

UNIT-II Multi Resolution Analysis and Wavelets: The Haar wavelet construction – Multi resolution analysis – Riesz basis to orthonormal basis – Sealing function and scaling identity – Construction of wavelet basis.

UNIT-III Compactly Supported Wavelets: Vanishing moment's property – Meyer's wavelets – Construction of a compactly supported wavelet – Smooth wavelets.

UNIT –IV Applications: Digital Filters – Discrete wavelet transforms and Multi resolution analysis – Filters for perfect reconstruction – Para unitary filters and orthonormal wavelets – Filter design for orthonormal wavelets – Biorthogonal filters.

Text and Reference Books:

1. C.K. Chui, "An introduction to Wavelets", Academic Press, San Diego, CA, 1992.
2. P. Wojtaszczyk, "A mathematical introduction to Wavelets", London Mathematical Society Student Texts 37, Cambridge University Press, 1997.
3. Y.T. Chan, "Wavelet Basics", Kluwer Academic Publishers, 1995.

Elective –III (One of the following is to be chosen)

1. **AM- 404 (A) Introduction to Modules**
2. **AM- 404 (B) Biological Network Analysis**
3. **AM-404 (C) Mathematical Statistics**

AM-404 (A) INTRODUCTION TO MODULES

Unit I: Basic definitions and examples, Quotient Modules and Module Homomorphism, Generation of Modules, Direct and Free Modules.

Unit II: Tensor product of Modules, Exact Sequences, Projective, Injective and Flat Modules.

Unit III: Algebras, Tensor Algebras, Symmetric and Exterior Algebras.

Unit IV: Modules over PID, the Rational and Jordan Canonical Forms

Text and Reference Books:

1. David S. Dummit and Richard M. Foote: Abstract Algebra, 3rd edition, John Wiley & Sons, 2004.
2. S. Lang: Algebra, 3rd edition, GTM, Springer, 2000.

AM 404 (B) Biological Networks Analysis

Unit-I: Networks and graph theory: Basic properties of Network: Degree, average degree and degree distribution. Adjacency matrix, weighted and unweighted networks, Bipartite network, Paths and distances, Erdos-Renyi model, Small-world effect, clustering coefficient. Scale-free networks: Power laws, Hubs, ultra-small property, degree exponent, The Barabasi-Albert Model. Degree correlations: assortativity and disassortativity.

Unit-II: Biological networks: Complex Biological Systems, Types of Biological networks, Intra-cellular networks: Gene-regulatory network, Protein-interaction network, Metabolic networks and Signaling network; Inter-cellular networks: Neuronal networks, Network motifs, Network medicine.

Unit-III: Modularity: Motifs and sub-graphs, Feed-forward loops, Single-input modules: LIFO, FIFO. Dense overlapping regulons (DORs). Optimal gene design circuits: fitness function and optimal expression of a protein in bacteria, Robustness.

Unit-V: Constraint-based modelling – Metabolic reconstruction, Flux Balance Analysis (FBA): Translating biochemical networks into linear algebra, Stoichiometric matrix, Elementary mode, Extreme pathways, Objective function, Optimization using linear programming. Genome-scale cellular models: Virtual Erythrocytes, Global human metabolic model.

Text and Reference Books:

1. Networks: An Introduction by M.E.J. Newman, Oxford University Press, 2010.
2. Introduction to Systems Biology: Design Principles of Biological Circuits by Uri Alon, Chapman & Hall/CRC, 2007.
3. Introduction to Systems Biology, S. Choi, Humana Press, 2007.
4. The New Science of Networks, Albert-László Barabási, Perseus Publishing, 2002.

AM -404 (C) MATHEMATICAL STATISTICS

UNIT-I SAMPLING DISTRIBUTIONS AND ESTIMATION THEORY Sampling distributions – Characteristics of good estimators – Method of Moments, Maximum Likelihood Estimation – Interval estimates for mean, variance and proportions.

UNIT-II: TESTING OF HYPOTHESIS: Type I and Type II errors - Tests based on Normal, t, Chi-square and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit.

UNIT- III: CORRELATION AND REGRESSION Method of Least Squares - Linear Regression – Normal Regression Analysis Normal Correlation Analysis Partial and Multiple Correlation - Multiple Linear Regression.

UNIT-IV : DESIGN OF EXPERIMENTS: Analysis of Variance – One-way and two-way Classifications – Completely Randomized Design – Randomized Block Design – Latin Square Design.

UNIT-V: MULTIVARIATE ANALYSIS :Covariance matrix – Correlation Matrix – Normal density function –Principal components – Sample variation by principal components – Principal components by graphing.

Text and Reference Books :

1. J.E. Freund,"Mathematical Statistics", Prentice Hall of India, 5th Edition, 2001.
2. R.A. Johnson and D.W. Wichern, "Applied Multivariate Statistical Analysis", Pearson Education Asia, 5th Edition, 2002.
3. Gupta S.C. and Kapoor V.K.,"Fundamentals of Mathematical Statistics", Sultan Chand & Sons, 11th Edition, 2003.

Course Code: MTH-S101 **Breakup: 3 – 1 – 0 – 4**
Course Name: Mathematics-I
Course Details:

Unit-I. Sequences & Series: Definition, Monotonic sequences, Bounded sequences, Convergent and Divergent Sequences Infinite series, Oscillating and Geometric series and their Convergence, n^{th} Term test, Integral test, Comparison Test, Limit Comparison test, Ratio test, Root test, Alternating series, Absolute and Conditional convergence, Leibnitz test.

Unit II. Differential Calculus: Limit Continuity and differentiability of functions of two variables, Euler's theorem for homogeneous equations, Tangent plane and normal. Change of variables, chain rule, Jacobians, Taylor's Theorem for two variables, Extrema of functions of two or more variables, Lagrange's method of undetermined multipliers.

Unit III. Integral Calculus: Review of curve tracing, Double and Triple integrals, Change of order of integration. Change of variables. Gamma and Beta functions. Dirichlet's integral. Applications of Multiple integrals such as surface area, volumes.

Unit –IV. Vector Calculus: Differentiation of vectors, gradient, divergence, curl and their physical meaning. Identities involving gradient, divergence and curl. Line and surface integrals. Green's, Gauss and Stroke's theorem and their applications.
Unit–V. Probability and Statistics: Concept of probability, random variable and distribution function: discrete and continuous, Binomial, Poisson and Normal Distributions.

Reference and Text Books:
1. G.B.Thomas and R.L.Finney : Calculus and Analytical Geometry, 9th edition, Pearson Educaion
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2005.

3. E. Kreyszig, Advanced Engineering Mathematics, 9th edition, John Wiley and Sons, Inc., U.K. 2011

4. R.K. Jain and S.R.K. Iyenger, Advanced Engineering Mathematics, 2nd Edition, Narosa Publishing House. 2005

5. M.D. Weir, J. Hass, F.R. Giordano, Thomas' Calculus, 11th Edition, Pearson Education.2008

MTH-S102 **Breakup: 3 – 1 – 0 – 4**

Course Name: Mathematics-II
Course Details:

Unit I. Matrix Algebra: Elementary operations and their use in finding Rank, Inverse of a matrix and solution of system of linear equations. Orthogonal, Symmetric, Skew-symmetric, Hermitian, Skew-Hermitian, Normal & Unitary matrices and their elementary properties.

UNIT II. Vector Space, Linear transformation, Linear dependent and linear independent, Eigen-values and Eigenvectors of a matrix, Cayley-Hamilton theorem, Diagonalization of a matrix.

Unit III. Ordinary Differential Equations of Second Order: Solution of linear differential equationsWith Constant coefficients. Euler-Cauchy equations, Solution of second orderDifferential equations by changing dependent and independent variables. Method of variation of parameters, Introduction to series solution method, Frobenious Methods.

Unit IV. Ordinary differential equations of higher orders: Matrix Method

Unit V. Laplace Transform: Laplace and inverse Laplace transform of somestandard functions, Shifting theorems, Laplace transform of derivatives andintegrals. Convolution theorem, Initial and final value theorem. Laplacetransform of periodic functions, error functions, Heaviside unit step functionand Dirac delta function. Applications of Laplace transform.

Text Books and Reference:

1. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2005.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2005.
3. C. Ray Wylie & Louis C. Barrett, Advanced Engineering Mathematics, Tata McGraw-Hill Publishing
Company Ltd. 2003.
4. G.F. Simmons, Differential Equations, Tata McGraw-Hill Publishing Company Ltd. 1981.

Course Code: MTH-S201 **Breakup: 3 – 1 – 0 – 4**

Course Name: Mathematics - III

Course Details:

Unit I. Function of a Complex variable: Complex numbers- power and roots, limits, continuity and derivative of functions of complex variable, Analytic functions, Cauchy-Reimann equations, Harmonic function, Harmonic conjugate of analytic function and methods of finding it, Complex Exponential, Trigonometric, Hyperbolic and Logarithm function.

Unit II. Complex Integration: Line integral in complex plane(definite and indefinite), Cauchy's Integral theorem, Cauchy's Integral formula, Derivatives of analytic functions, Cauchy's Inequality, Liouville's theorem, Morera's theorem, Power series representation of analytic function and radius of convergence, Taylor's and Laurent's series, singularities, Residue theorem, Evaluation of real integrals, Improper Integrals of rational functions.

Unit III. Fourier series: Trigonometric Fourier series and its convergence. Fourierseries of even and odd functions. Fourier half-range series. Parseval`sidentity. Complex form of Fourier series.

Unit IV. Fourier Transforms: Fourier integrals, Fourier sine and cosine integrals, Fourier transform, Fourier sine and cosine transforms and their elementaryproperties. Convolution theorem. Application of Fourier transforms to BVP.Laplace

Unit V. Partial Differential Equations: Formation of first and second order partialdifferential equations. Solution of first order partial differential equations:Lagrange`s equation, Four standard forms of non-linear first order equations.

Text Books and Reference:

1. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2005.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2005.

Code: MTH-S301 **Breakup: 3 – 1 – 0 – 4**

Course Name: Discrete Mathematics

Course Details:

Unit I. Introduction to formal logic, Formulae of prepositional logic, Truth tables, Tautology, Satisfiability, Contradiction, Normal and principle normal forms, Completeness. Theory of inference. Predicate calculus: Quantifiers, Inference Theory of predicate logic, Validity, Consistency and Completeness.

Unit II. Sets, Operations on sets, Ordered pairs, Recursive definitions, Relations and Functions, Equivalence relations, Composition of relations, Closures, Partially ordered sets, Hasse Diagram's, Lattices (Definition and some properties).

Unit III. Algebraic Structures: Definition, Groupoid, Monoid, Semi groups, Groups, Subgroups, Abelian groups, Cyclic groups.

Unit IV. Graph Theory: Incidence, Degrees, Walks, Paths, Circuits, Charactarization theorems, Connectedness, Euler graphs, Hamiltonian graphs, Travelling salesman problem, Shortest distance algorithm (Djkstra's), Trees, Binary trees, Spanning trees, Spanning tree algorithms Kruksal's and Prim's.

Unit-V. Boolean Algebra: Properties of Boolean Algebra, Sub Boolean Algebra, Ideals, Switching Circuits

Text Books and Reference:

1. C.L.Liu : Discrete Mathematics
2. B.Kolman, R.C.Busby, and S.C.Ross, Discrete mathematical structures, 5/e, Prentice Hall, 2004
3. J.L.Mott, A.Kandel and T.P.Baker : Discrete mathematical structures For computer scientists & Mathematicians, Prentice–Hall India
4. J.P.Trembley, R. Manohar, Discrete mathematical structures with applications to computer science, McGraw –Hill, Inc. New York, NY,1975