Mathematics

Sl.No	Subject Code	Name of the Subject
1	14PHDMA001	Ordinary and Partial differential equations
2	14PHDMA002	Advanced Numerical Methods
3	14PHDMA003	Advanced Fluid Mechanics and Magneto hydrodynamics
4	14PHDMA004	Complex analysis
5	14PHDMA005	Advanced Graph theory
6	14PHDMA006	Probability and Stochastic process
7	14PHDMA007	Operation Research
8	14PHDMA008	Computer Fundamentals and Programming in C
9	14PHDMA009	Integral Transforms & Calculus of Variation
10	14PHDMA010	Linear Algebra
11	Compulsory	Research Methodology

14PHDMA001: Ordinary and Partial differential equations

Series Solution of linear differential equations

Power series solutions about an ordinary point, Singular points, Frobenious method, Bessel equations and Bessel functions, Legendre functions, Laguerre functions.

Existence and uniqueness theory

Existence and uniqueness theory for ordinary differential equations, Eigen value problem, Sturm-Lioville equations, The Green's function technique for second order equations.

Non linear differential equations

Phase plane, paths and critical points, critical points and paths of linear system, critical points and paths of nonlinear system

Classification of second order PDE

Canonical forms, adjoint operators, Riemann's method.

Elliptic differential equations

Derivation of Laplace and Poisson equation, Boundary value problems, some important mathematical tools, properties of harmonic functions, separation of variables, Dirichlet problem for rectangle and circle, Neumann problem for rectangle and circle, Mixed boundary value problems.

Parabolic differential equations

Occurrence, boundary condition, elementary solutions, separation of variables, solution in cylindrical and spherical coordinate systems.

Hyperbolic differential equations

occurrence, derivation of one dimensional wave equation, solution of one dimensional canonical reduction, initial value problem, D'Alembert's solution, vibrating string – variable separable method, boundary and initial value problem for two dimensional wave equation – method of Eigen function, uniqueness of the wave equation, Duhamel's principle.

Transform methods

Laplace transform of Bessel functions, solution of diffusion equations and wave equations by Laplace and Fourier Transform method. Fourier transform for Laplace equation.

Reference books: **1.** Differential Equations with applications and Historical Notes, G.F. Simmons.

2. Elements of ordinary differential equations and special functions by A. Chakrabarty, New age international
3. Introduction to Partial Differential Equations by K. Sankara Rao, 2nd edition.

14PHDMA002: Advanced Numerical Methods

High Speed Computation

Introduction, computer Arithmetic, errors in numerical Techniques, machine computation and computer software.

Transcendental and Polynomial Equations

Introduction, Newton Raphson method, Secant and Regula falsi method , rate of convergence, Newton McAuley method for multiple roots. Birge – Vieta method, Bairstow method, Graffe's root squaring method.

System of Linear Algebraic Equations and Eigen value Problems

Introduction,Consistency, Rank of a matrix Gaussian elimination, LU decomposition, Gauss-Siedel and Successive over relaxation methods, Tridiagonal system of equations

Eigen values and Eigenvectors, bounds on Eigen values, Jacobi's Method for Symmetric Matrices, Given Method for Symmetric Matrices, Householder's Method for Symmetric Matrices, largest Eigen value by power method.

Interpolation and Approximation

Introduction, Lagrange and Newton Interpolations, Interpolating polynomials - piecewise polynomial interpolation, Spline's interpolation formula, Hermite Interpolation, Bivariate Interpolation, least square approximations

Numerical integration

Newton's cotes formula, Simpson's rules, Weddle's rule, Gaussian Quadrature – Gauss Legendre and Gauss Chebyshev methods, double integration

Ordinary Differential Equations: Boundary Value Problems

Initial Value Problem and boundary value problem, 4^{th} order Runge – Kutta's Method for 1^{st} and 2^{nd} order ordinary differential equations, system of equations predictor – corrector formulae, shooting method and finite difference methods for BVP.

Partial Differential Equations

Finite difference approximation to derivatives. Laplace equation – Jacobi, Gauss Siedel and SOR methods, ADI method, Parabolic equations, explicit and implicit methods, Hyperbbolic equations

Reference books: 1. Numerical methods for scientific and engg. Computation, by M K Jain, S R K Iyengar and R K Jain, 6^{th} edition , New Age, 2012

2. Introductory methods of numerical analysis by S S Sastry, 4^{th} edition, PHI, 2011

14PHDMA003: Advanced Fluid Mechanics and Magneto hydrodynamics

Real fluids and ideal fluids, velocity of fluid at a point, streamlines, pathlines, streamlines, velocity potential, vorticity vector, local and particle rate of change, equation of continuity, irrotational and rotational motion, acceleration of fluid, conditions at rigid boundary.

Euler's equation of motion, Bernoulli's equation, axially symmetric flows, impulsive motion, Kelvin's Theorem of circulation, equation of vorticity. Some three dimensional flows, sources, sinks and doublets, images in rigid planes, images in solid sphere. Stoke's stream function. Two Dimensional Flows: Complex velocity potential, Milne Thomson Circle Theorem,

Viscous Flows: Stress components, Stress and strain terror, Coefficient of viscosity and Laminar flow, Plane Poiseuille flows and Couette flow. Flow through tubes of uniform cross section in the form of circle, Ellipse, equilateral triangle, annulus, under constant pressure gradient, steady flow past a fixed sphere.

Dimensional analysis, Reynold numbers, Prandtl's boundary layer, Boundary layer equation in two dimensions, Karman integral equation.

Non- Newtonian fluids, rheological classification , time dependent, thixotropic, viscoelastic fluids, constitution of blood, viscocity of blood, steady non- Newtonian fluid flows in circular tubes, Fahraeus-Lindqvist effect, Pulsatile flow in circular rigid tube, flow through atrtery with stenosis, Peristaltic flow in a tube, long wave length approximation.

Basic equations of MHD including Faraday's laws and constitutive laws. Magnetic induction equation – Lorentz force – MHD approximations. Non-dimensional numbers – velocity, temperature and magnetic field boundary conditions. Hartmann flow – isothermal boundary conditions – temperature distribution in Hartmann flow – Hartmann couette flow. Classical MHD and Alfven's wave, Alfven's theorem, Frozen – n – phenomenon and equipartition of energy by Alfven's wave

References :

1. Batchler, G. K: An Introduction to Fluid Mechanics, Cambridge University Press.
2. Hydrodynamic and hydro magnetic stability by S. Chandrasekhar, Dover's university
3. Mathematical Models in Biology and Medicine by J. N. Kapur.

14PHDMA004: Complex analysis

Complex Integration

Complex line integrals, simply and multiply connected regions,Cauchy's theorem, some consequences of Cauchy theorem, Cauchy's integral formula, Morera's theorem, Liouville's theorem.

Taylor's series and Laurent series

Taylor's theorem, Taylor series, Laurent's series, classification of singularities, Entire function, Lagrange's expansion, Analytic continuation

Residues and evaluation of Integrals

Residues , calculation of residues, Residue theorem, Evaluation of definite integrals,Mittag – Leffer series.

Conformal mapping

Transformation or mapping, Jacobian of transformation, conformal Mapping, Riemann's mapping theorem, fixed and invariant points of transformation, Translation, rotation, strtching and inversion. Bilinear trnsformation, The Schwarz – Christoffel transformation

References:

1. Complex Analysis by Ahlfors, McGraw Hill Publications,
2. Functions of one complex variable by Convay, Narosa publications, New Delhi.

14PHDMA005: Advanced Graph theory

.

Varieties of graphs, walks and connectedness, degrees, problem of Ramsey, extremal graphs, intersection graphs, operations on graphs

Cut points, bridges and blocks, block graphs and cutpoint graphs,

Trees - characterisation of trees, centers and centroids, block cutpoint trees, independent cycles and cocycles, Matroids

Connectivity and line connectivity, Graphical variations of Menger's theorem, Partitions

Eulerian and Hamiltonian graphs, Line graphs, properties and characterizations of line graphs, line graphs and transversability, Total graphs

Coverings and independence, critical points and lines, Planes and planar graphs, outerplanar graphs, Kurtowski's theorem

Colorability, the chromatic number, Five color theorem, Four color conjencture,The Heawood map coloring theorem, Uniquely colorable graphs, critical graphs

The adjucency matrix, incidence matrix, cycle matrix

Digraphs – digraphs and connectedness, directional dualty and acyclic digraphs, digraphs and matrices

Reference Books

1. Graph Theory, by F. Harary Addition Wesley Reading Mass, 1969.
2. Graph Theory With Applications to Engineering and Computer Science, by N. Deo, Prentice Hall of India, 1987

14PHDMA006: Probability and Stochastic process

Probability – Random experiments, sample paces, event, axioms, addition and multiplication, conditional probability, independent events, Baye's theorem.

Random variable, discrete probability distribution, continuous random variables, continuous probability distribution, Cumulative distribution function, expected value.

Continuous and discrete Joint distribution, expectation, variance, standard deviation, covariance

Binomial, Poisson, Exponential, Normal, Hyper geometric relations, gamma distribution, Weibull distribution

Population and sample, sampling with and without replacement, sampling distribution of means, sample variance. Unbiased estimate, reliability, confidence intervals for mean, statistical hypothesis, testing of hypothesis, Type I and II errors, one tailed, two tailed tests, t - distribution, χ^2 – test, test for goodness of fit.

Markov Chain: States and transitions, Transition probabilities, General two-state Markov chain, Powers of the transition matrix for the *m*-state chain Gambler's ruin as a Markov chain, Classification of states , Classification of chains, problems

Reference Books

1. Probability and statistics, by Murray R Spiegel, J Schiller, R Alu Srinivasan, Schaum's outline series, second edition
2. Probability and Stochastic processes by Roy .D. Yates and David J Goodman, Wiley, second edition, 2005

14PHDMA007: Operation Research

Linear Programming

Formulation, Graphical method, Simplex Method, Two Phase method, Big M Method, Dual Simplex method

Assignment Models

Formulation, Hungarian Method, Travel Salesman problem

Transportation Models

Mathematical Formulation, Matrix form, North west corner method, Vogel's method for Feasible solution, Stepping stone and Modified distribution method for Optimality test,

Game theory

Basic definition, Saddle points, Principles of Dominance, Games without Saddle point, Arithmetic method, Graphical method, Linear Programming method

Queuing Theory

Introduction, types of Queuing models, Kendal's notations, Single channel and multiple channel queues, M/M/1:∞/ FCFS and M/M/k:∞/ FCFS Types of queues

CPM and PERT

Basic definitions, Network components, Rules for Network construction, Critical path method, Program Evaluation and review technique, Distinction between PERT and CPM

Reference Books:

Operation research by S D Sharma, Kedarnath Ramnath & Co, 2005

14PHDMA008: Computer Fundamentals and Programming in C

An overview of functioning of a computer system, Components of a computer system, I/O and auxiliary storage devices ,machine and high level languages, assembler, compiler and interpreters, flow charts and pseudo codes, Basic concepts of operating system.

Introduction to C Essentials – Programs development, Functions. Anatomy of a Function. Variables and Constants Expressions. Assignment Statements, Scalar Data types – Declarations, Different Types of integers. Different kinds of Integer Constants

Floating – point type Initialization, mixing types Explicit conversions – casts Enumeration Types. the void data type, Type definitions. Operators and expression in C-Precedence and associativity, Control flow statements Conditional branching, the switch statement, looping, nested loops, the break and continue statement, the go to statement, infinite loops.

Arrays and multidimensional arrays. Storage classes-fixed vs. automatic duration scope, global variable the register specifier, Functions –user defined and library function, Introduction to pointers, structures and unions. Introduction to C++: Declaration & Definition of Variables, Data Types, Operators, OOPS Fundamentals: OOPS Versus procedural programming, OOPS terminology, Data abstraction, Data hiding, Encapsulation, Class, Object, Inheritance, Polymorphism.

References:

1. Computer fundamental by Rajaraman
2. Operating systems concepts by Peterson
3. Programming in ANSI C by E. Balaguruswamy, Tata-McGraw Hill, New Delhi.
4. Programming in C++ by E. Balaguruswamy, Tata-McGraw Hill, New Delhi.
5. Schaum's outline series.
6. Let us C by Y. Kanetkar.
7. Brain W Kernigham & Dennis M Ritchie the C Programmed language, 2nd edition (ANSI features), Prentice Hall 1989.

14PHDMA009: Integral Transforms & Calculus of Variation

Functionals, Linear Functionals, Fundamental Lemma of Calculus of Variations Simple Variational Problems, The Variation of Functional, the Extermum of Functional, Necessary Condition for Extreme, Euler's Equation, Euler's Equation of Several Variables, Invariance of Euler's Equation. Motivating Problems of Calculus of Variation, Shortest Distance, Minimum Surface of Revolution, Brachistochrone Problem, Isoperimetric Problem, Geodesic. The Fixed End Point Problem for 'n' Unknown Functions, Variational Problems in Parametric form, Generalization of Euler's Equation to
(i) 'n' Dependent Functions (ii) Higher Order Derivatives.

Variational Problems with Subsidiary Conditions, Derivation of the Basic Formula, End Points Lying on Two Given Curves or Surfaces.

Integral Transform: Laplace Transform; Transform of Elementary Functions, Transform of Derivatives, Inverse Transform, Convolution Theorem, Applications: Ordinary and Partial Differential
Equations.

Fourier Transform, Sine and Cosine Transform, Inverse Fourier Transform, Application to Ordinary and Partial Differential Equations.

References:

1. I. M. Gelfand & S. V. Fomin: Calculus of Variations, Prentice-Hall.
Chapter -III (13,14) Chapter –2 (9,10,11,12) .
2. L Debnath : Integral Transforms and their Applications, CRC Press, 1995.
3. R. Charchill, Operational Mathematics, McGraw Hill, New York 1972.
4. I. N. Sneddon: The use of Integral Transform, McGraw Hill, New York 1972.

14PHDMA010: Linear Algebra

Vector Spaces: Definition and Examples, Subspaces, Bases and Dimensions, Linear Transformations, Quotient Spaces, Direct Sum, The matrix of Linear Transformation, Duality, Eigen values and Eigenvectors, The minimal Polynomial, Diagonalisability, Triangularisable

Canonical and Bilinear Forms: Jordan Forms, The Rational Forms, Bilinear Forms : Definition and Examples, The matrix of a Bilinear Form, Orthogonality, Classification of Bilinear Forms.

Inner Product Spaces : Inner Product Spaces, Orthogonality, The Adjoint of Linear Transformation, Unitary operators, Self Adjoints and Normal Operators, Polar and Singular Value, Decomposition**.**

Symmetric Matrices and Quadratic forms: Diagonalization of symmetric matrices , quadratic form, constrained optimization, the singular value decomposition

References:

1. Algebra by S. Mclane and G. Birkhoff
2. Linear algebra by S. Lang, Springer
3. Linear Algebra by Bisht and Sahai
4. Linear Algebra by Hoffman and Kunze, P.H.I
5. Linear algebra and its applications, David C. Lay, Pearson