Mathematics

M. Phil/Ph.D Course Work Syllabus

Course Code	Course Name	Credits	Marks
MAT-RS-C501	Research Methodology	4	100
MAT-RS-O502	Research Proposal and Preparation	4	100
MAT-RS-E503	Differential Quadrature methods and Applications	4	100
MAT-RS-E504	Mesh-free methods and Applications	4	100
MAT-RS-E505	Computational method for PDE	4	100
MAT-RS-E506	Commutative Rings	4	100

MAT-RS-C501: Research Methodology and Advanced Mathematics

UNIT I: Used of computer/Programming

LaTex and Beamer typing

Concept of computer language-Fortran 90 programming,

Matlab, Mathematica, CoCoa software, Origin

UNIT II, III &IV : Quantitative method & Problem solving in Mathematics

Problem solving in Algebra and Number Theory, Problem Solving in Analysis and Differential Equations, Problem Solving in Topology and Complex Function Theory.

MAT-RS-C502: Research Proposal and Preparation

Unit I & II: Review of a scientific research paper

Studying a research paper and writing a review of the same, identifying any new problem, question, and direction emanating from the paper.

Unit III & IV: Research proposal

The students will write a detailed proposal of their research including a thorough review of literature on a topic of their choice and present the same in a seminar at least 10 days before the End-Semester examination.

MAT-RS-E503: Differential Quadrature Methods and its Applications

Unit-I: Introduction to Differential Quadrature

Introduction, differential quadrature, analysis of linear vector space, properties of linear vector space, solutions of partial differential equations and function approximations, Fourier series expansion, general functions, even functions, odd functions.

Unit-II: Polynomial based differential quadrature (PDQ)

Computation of weighting coefficients of the first order derivative, Bellman's approaches, Quan and Chang's approach, Shu's general approach.Computation of weighting coefficients for the second and higher order derivatives, Shu's recurrence formulation for higher order derivatives.Matrix multiplication approach.

Unit-III: Fourier expansion based differential quadrature (FDQ)

Cosine expansion based differential quadrature (CDQ) for even functions, Sine expansion based differential quadrature (SDQ) for odd functions, Fourier expansion based differential quadrature (FDQ) for general functions.

Unit-IV: Solution techniques for differential quadrature (DQ) resultant equations

Solution techniques for differential quadrature of ordinary differential equations (ODEs), Implementations of boundary conditions.Sample applications of DQ method to Burgers' equation, Two-dimensional Poisson equation and Helmholtz eigenvalue problems.

Text Book:

1. C. Shu, Differential Quadrature and its application in Engineering, Springer-Verlag London Ltd., Great Britain, 2000.

2. ZhiZong and Yingyan Zhang, Advanced Differential Quadrature Methods, CRC press, London, 2009.

MAT-RS-E504: Mesh-free methods and Applications

Unit I: Overview of meshfree methods

Why Meshfree methods, Definition of Meshfree methods, Solution procedure of MFree methods, Categories of Meshfree methods, Classification according to the formulation procedures-Meshfree methods based on weak-forms-Meshfree methods based on collocation techniques-Meshfree methods based on the combination of weakformand collocation techniques.

Unit II: Meshfree methods based on the moving least squaresapproximation

Moving least squares shape functions, Formulation of MLS shape functions, Choice of the weight function, Properties of MLS shape functions, Examples of MLS shape functions, Interpolation error using Meshfree shape functions, Fitting of a planar surface, Fitting of a complicated surface.

Unit III: Element Free Galerkin Method

EFG Formulation with Lagrange Multipliers, EFG with Penalty Method, Some simple applications.

Unit IV: Meshless Local Petrov–Galerkin Method

MLPG Formulation, The Idea of MLPG, Formulation of MLPG, Types of Domains, Application to some simple problems**.**

Text Books:

1. G.R. LIU, Y.T. GU, AN INTRODUCTION TO MESHFREE METHODS AND THEIR PROGRAMMING, Springer -2005.

2. G.R. LIU, MeshFree methods: moving beyond finite element methods, CRC Press London, 2003.

MAT-RS-E505: COMPUTATIONAL METHODS FOR THE PDE

Unit – I: Partial Differential Equations

Introduction, Difference methods, Routh Hurwitz Criterion, Domain of dependence of hyperbolic equations

Uni t – II: Difference methods in Parabolic PDEs

Introduction, One space dimension, Two space dimensions, variable coefficients problems, spherical and cylindrical coordinate systems

Unit –III: Difference methods for hyperbolic PDEs

Introduction, One space dimension, Two space dimensions, first order equations, systems of first order equations

Unit – IV: Numerical methods for elliptic PDEs

Difference methods for linear BVPs, General second order linear equations, quasilinear elliptic equations

Text Book:

1. Williams F Ames, Numerical Methods in PDE, Academic Press, New York, **1977.**

2. Paul Duchateau and David W Zachmann, Partial Differential Equations – Schaum's Outline Series, McGraw-Hill, **1986**

MAT-RS-E506: COMMUTATIVE RINGS

UNIT I: Prime Ideals and applications

Prime ideals, G-domains, G-ideals, Hilbert rings, Hilbert Nullstellensatz

UNIT II: Localization and Integral Extension

Localization, Prime ideals in polynomial rings,Integralextensions,Going-up and Going-down theorems, Valuation domains, Prufer domains and Bezout domains.

UNIT III:Noetherian Rings & Factorization

Noetherian rings, Hilbert basis theorem, Krull's intersection theorem, Nakayama lemma, Zero divisors, Discrete valuation rings, Dedekind domains, Krull domains.

UNIT IV: Cohen Macaulay & Regular Rings

R-sequences, Cohen-Macaulay rings, Principal ideal theorem, Generalised principal ideal theorem, Regular rings.

Text book:

1. Commutative Rings by Irving Kaplansky, Chicago universitypress,1968.

Reference Books:

1. Commutative Ring Theory by Hideyuki Matsumura, Cambridge studies in advanced mathematics 8, Cambridge universitypress,Cambridge,1989.

2. Introduction to Commutative Algebra by M.F.Atiyah andI.G. Macdonald, Addison- Wesley Publ. Company, 1969.

3. Local Algebra by Jean-Pierre Serre(translated from theFrench by CheeWhye Chin), Springer,1999.