Department of Mathematics, Kakatiya University

Pre-Ph.D. (Mathematics) (w.e.f. 2023-2024)

Programme - Structure

S. No.	Stream	Subjects
1.	**Pure Mathematics**	a) Advanced Complex Analysis
2.	**Applied Mathematics**	a) Numerical Solutions of Differential Equations b) Solid Mechanics and Boundary Value Problems of Partial Differential Equations
3.	**Applied Statistics**	a) Fuzzy Sets and Fuzzy Logic b) Markov Chains – Numerical Solutions c) Reliability Theory

Department of Mathematics, Kakatiya University
Pre-Ph.D (Mathematics) (w.e.f. 2023-2024)
Paper-I
Research Methodology and Technical Writing

Unit-I

Research Methodology

Meaning of Research – Objectives of Research –Motivation in Research – Types of Research – Significance of Research – Review of the Literature – Writing Strategies – Mathematics and Computer Science Citation –Mathematical Subject Classification (MSC).

Unit-II

Research Metrics

Journals –Science Citation Indexing (SCI)– Engineering Indexing (EI) and Scopus Indexing – Impact Factor (IF) – Immediacy Index – H-index, definition, purpose, calculation, advantages and disadvantages – Research ethics and morals – Plagiarism & Software tools – Acknowledgement and its index – Intellectual copy rights.

Unit-III

MSWord and LaTeX

Manuscript and research project preparation using MSWord and LaTeX – Sample document type style, environments, lists, centering, tables, GANTT charts, verbatim, vertical and horizontal spacing, equation environments, fonts, hats and underlining, braces, arrays and matrices, customized commands, maths styles, document classes and overall structure, titles for documents, sectioning commands, packages, inputting files, pictures, making a bibliography, making an index – Research project reports – Preparation of PPT slides.

Unit-IV

MATLAB

Arithmetic operations – Built-in-Math functions, scalar variables, creating arrays – Built- in-functions for handling arrays – Mathematical operations with arrays and matrices, script files – Programming in MATLAB, two dimensional plots, three dimensional plots, polynomial, curve fitting and interpolation.

Board of Studies in Mathematics, Kakatiya University

Chairperson
BoS in Mathematics
Kakatiya University,
Warangal 506009

Text Books:

1. C.R.Kothari: Research Methodology, New Age International Publishers.
2. John W. Creswart : Research Design, Sage Publications India Pvt.Ltd., Third Edition.
3. Charles Lipson: Cite Right, The University of Chicago Press.
4. Hilary Glasman Deal, Science Research Writing, Imperial College Press.
5. www.wikipedia.org
6. LaslieLamport: LATFX, Addison Wesley Publications Company (1994).
7. David F: Griffiths, Desmond J.Higham: Learning LATEX. Society for Industrial and Applied Mathematics, Philadelphia (1997).
8. RudraPratap: Getting Started with MATLAB, Oxford University Press, 2002.

Board of Studies in Mathematics, Kakatiya University

Chairperson
BoS in Mathematics
Kakatiya University.

Department of Mathematics, Kakatiya University
Pre-Ph.D (Mathematics) (w.e.f. 2023-2024)
Pure Mathematics Stream
Paper-II
Advanced Complex Analysis

Unit-I (2 Questions)

Analytic and Harmonic Functions: Analytic functions – Cauchy-Riemann equations – Harmonic functions – Borel-Caratheodory theorem – Poison's integral formula – Positive harmonic functions – Harnack's functions – Harnack's inequality – Harnack's principle.

Scope as in: Complex Variables – Herb Silverman – Complex Variables Theory and Applications – H. S. Kasana.

Unit-II (2 Questions)

Conformal Mappings and Bilinear Transformations: Introduction – Conformality theorem – Bilinear transformations – Special bilinear transformations – Exponential transformations – Trigonometric transformations – Normal families – Riemann mapping theorem.

Scope as in: Complex Variables – Herb Silverman – Complex Variables Theory and Applications – H. S. Kasana.

Unit-III (2 Questions)

Elementary Theory of Univalent Functions: Definition of univalent functions and elementary properties – Area theorem – Coefficient conjucture – Coefficient estimates – Growth and distortion theorems to the class 'S' – Function with positive real part.

Scope as in: Complex Variables – Herb Silverman – Univalent Functions – P. L. Duren – Univalent Functions – A. W. Goodman (Vol.I).

Unit-IV (2 Questions)

Sub Classes of 'S': Starlike and convex functions – Close to convex functions – Spiral like functions $-\alpha$-convex functions $-\alpha$-spiral like functions – Basic properties – Coefficient estimates – Rotation theorem.

Scope as in: Complex Variables – Herb Silverman – Univalent Functions – P. L. Duren – Univalent Functions – A. W. Goodman (Vol.I).

Board of Studies in Mathematics, Kakatiya University

Chairperson
BoS in Mathematics
Kakatiya University,
Warangal 506009

166 99

Department of Mathematics, Kakatiya University
Pre-Ph.D (Mathematics) (w.e.f. 2023-2024)
Applied Mathematics Stream
Paper-II
Numerical Solutions of Differential Equations

Unit-I (2 Questions)

Elements of Ordinary Differential Initial Value Problem Approximation: Introduction – Initial value problems – Difference equations - Numerical methods – Stability analysis of Numerical Methods – Convergence analysis of Numerical Methods.

Singlestep Methods: Introduction – Taylor Series Method – Runge- Kutta Methods: Second order, Third order and Fourth order methods.

Multistep Methods: Introduction – Explicit Multistep Methods: Adams Bashforth Formulas $(j=0)$, Nystrom's Formula $(j=1)$, Formulas for $j=0,1,3,5$ – Implicit Multistep Methods: Adams- Moulton Formulas $(j=0)$, Milne- Simpson Formulas $(j=1)$.

Scope as in Numerical Solution of Differential Equation's by M. K. Jain, Chapters 1.1, 1.2 , 1.3, 1.5, 1.6, 1.7, 2.1, 2.2, 2.3 (2.3.1, 2.3.2, 2.3.3), 3.1, 3.2(3.2.1, 3.2.2, 3.2.3) and 3.3

Unit-II (2 Questions)

Difference Methods for Boundary Value Problems in Ordinary Differential Equations: Introduction – Approximate methods: Shooting methods , Difference methods , Difference approximation to derivatives – Nonlinear boundary value problem $y'' = f(x,y)$: Difference scheme based on quadrature formulas , Second order linear boundary value problems , Solution of tridiagonal system.

Scope as in Numerical Solution of Differential Equation's by M. K. Jain, Chapters 4.1, 4.2, 4.3(4.3.1, 4.3.2, 4.3.3)

Unit-III (2 Questions)

Finite Element Methods: Introduction – Weighted residual methods: Least square method, Partition method, Galerkin method – Variational methods: Ritz method.

Finite elements: Line segment element, Triangular element, Rectangular element.

Finite elements methods: Least square finite element method, Galerkin finite element method.

Scope as in Numerical Solution of Differential Equation's by M. K. Jain, Chapters 8.1, 8.2 (8.2.1, 8.2.2, 8.2.3), 8.3, 8.4 (8.4.1 to 8.4.3), 8.5 (8.5.2, 8.5.3)

Board of Studies in Mathematics, Kakatiya University

~~162~~
167 ~~100~~

Chairperson
BoS in Mathematics
Kakatiya University,
Warangal 506009

Unit-IV (2 Questions)

The Numerical Solution of Partial Differential Equations: Difference methods for parabolic partial differential equations: Introduction, One space dimension, Two space dimension.

Difference methods for hyperbolic partial differential equations: Introduction, One space dimension, Two space dimension.

Numerical Methods for elliptic partial differential equations: Introduction, Difference methods for linear boundary value problems, General second order linear equations.

Scope as in Computational Methods for Partial Differential Equations Chapters 2 (2.1 to 2.3), 3 (3.1 to 3.3), 4 (4.1 to 4.3)

Text Books:

1. Numerical Solution of Differential Equations by M. K. Jain
2. Computational Methods for Partial Differential Equations by M. K. Jain, S. R. K. Iyengar, R. K. Jain.

Board of Studies in Mathematics, Kakatiya University

163 40+168

Chairperson
BoS in Mathematics
Kakatiya University,
Warangal 506009

Department of Mathematics, Kakatiya University
Pre-Ph.D (Mathematics) (w.e.f. 2023-2024)
Applied Mathematics Stream
Paper-II
Solid Mechanics and Boundary Value Problems of Partial Differential Equations

Unit - I (2 Questions)

Curvilinear Coordinates: Transformation of coordinates–Orthogonal curvilinear coordinates –Unit vectors – Arc length and volume elements – The gradient, divergence, and curl – Special orthogonal coordinate systems: Cylindrical coordinates and Spherical coordinates.

Tensors: Coordinate transformations – Summation Convention –Contravariant– Covariant and mixed tensors – Symmetric and skew symmetric tensor – Fundamental operations with the tensors – The line element and metric tensor – Conjugate tensor – Tensor form of gradient, divergence and curl.

Unit - II (2 Questions)

Classification of partial differential equations of second order.

Boundary Value Problems (BVP): Derivation of wave equation – Derivation of heat equation – Derivation of Laplace equation.

Method of separation of variables – Principle of superposition – Solution of BVP by method of separation of variables – One dimensional heat equation – Two dimensional heat equation – One dimensional wave equation – Two dimensional wave equation.

Unit - III (2 Questions)

Analysis of Strain: Deformation – Affine transformations – Infinitesimal affine transformations – Geometrical interpretation of the components of strain – Strain quadric of Cauchy – Principal strain and strain invariants – Examples of strain – Equations of compatibility (a simple derivation).

Analysis of Stress: Body and surface forces – Stress tensor – Equations of equilibrium – Transformation of coordinates – Stress quadric of Cauchy – Maximum normal and shear stress – Mohr's diagram – Examples of stress.

Board of Studies in Mathematics, Kakatiya University

~~164~~ ~~102~~ 169

Chairperson
BoS in Mathematics
Kakatiya University,
Warangal 506009

Text Book:

1. Fuzzy Logic with Engineering Applications, Thimothy J Ross, 2nd Edition, John Wiley & Sons Ltd.

Reference Books:

1. Fuzzy Sets, Uncertainty, and Information, George J Klir& Tina A Folger, 2nd Edition, Prentice Hall Ltd.
2. Fuzzy Sets and Fuzzy Logic - Theory & Applications, George J Klir& Bo Yuan, Prentice Hall Ltd.
3. Fuzzy Mathematics - An Introduction for Engineers and Scientists, John N. Mordeson, Premchand S. Nair, 2nd Edition, Springer Verlag.

Board of Studies in Mathematics, Kakatiya University

~~167~~ 105172

Chairperson
BoS in Mathematics
Kakatiya University,
Warangal 506009

Department of Mathematics, Kakatiya University
Pre-Ph.D (Mathematics) (w.e.f. 2023-2024)
Applied Statistics Stream
Paper-II
Fuzzy Sets and Fuzzy Logic

Unit – I (2 Questions)

Introduction to Fuzzy Logic - An Historical Perspective - The Utility of Fuzzy Systems - Limitations of Fuzzy Systems - Uncertainty and Information - Fuzzy Sets and Membership - Classical Sets and Fuzzy Sets - Operations and Properties - Cartesian Product - Crisp Relations - Fuzzy Relations - Value Assignments.

(Chapters 1-3 of Text Book)

Unit – II (2 Questions)

Features of the Membership Function – Various Forms –Fuzzification–Defuzzification to Crisp Sets - λ-cuts for Fuzzy Relations –Defuzzification to Scalars – Classical Logic – Fuzzy Logic – Natural Language – Linguistic Hedges – Fuzzy (Rule-Based) Systems – Graphical Techniques of Inference –Membership Value Assignments.

(Chapters 4 - 6 of Text Book)

Unit – III (2 Questions)

Automated Methods for Fuzzy Systems –Definitions – Batch Least Squares Algorithm - Recursive Least Squares Algorithm – Gradient Method - Clustering Method –Fuzzy Systems Simulation –Fuzzy Relational Equations - Nonlinear Simulation Using Fuzzy Systems – Fuzzy Associative Memories (FAMs).

(Chapters 7 – 8 of Text Book)

Unit – IV (2 Questions)

Fuzzy Synthetic Evaluation - Fuzzy Ordering –Non-transitive Ranking - Preference and Consensus - Multiobjective Decision Making – Fuzzy Bayesian Decision Method - Decision Making under Fuzzy States and Fuzzy Actions – Extension Principle – Fuzzy Arithmetic – Interval Analysis in Arithmetic – Approximate Methods of Extension

(Chapters 10, 12 of Text Book)

Board of Studies in Mathematics, Kakatiya University

Unit - IV (2 Questions)

Equations of Elasticity: Generalized Hooke's law – Homogeneous isotropic media – Elastic moduli for isotropic media – Simple tension – Pure shear and hydrostatic pressure – Equilibrium equations for an isotropic elastic solid – Dynamical equations for an isotropic elastic solid – The strain energy function and it's connection with Hooke's law.

Basic Problems of Elasticity: Statement of problem – Extension of beams by longitudinal forces – Beam stretched by its own weight – Bending of beams by terminal couples – Torsion of circular shaft – Torsion of cylindrical beams – Stress function.

Text Book:

1. Vector Analysis (Introduction to Tensors) by Murray R Spiegel, Schaum's Series.
2. Advanced Differential Equations by M. D. Raisinghania.
3. Mathematical Theory of Elasticity by I. S. Sokolnikoff, TMG- New Delhi.

165

103 170

Chairperson
BoS in Mathematics
Kakatiya University,

Department of Mathematics, Kakatiya University
Pre-Ph.D (Mathematics) (w.e.f. 2023-2024)
Applied Statistics Stream
Paper-II
Markov Chains – Numerical Solutions

Unit-I (2 Questions)

Poisson Process and Markov Chains: Definition and examples of stochastic process - Poisson process - Markov chains - The Chapman Kolmogorov equations – Classification of states – Mathematical Classification – The stationary distribution of ergodic chains – Balance equations for stationary probabilities – Uniqueness of stationary probabilities.

Sections 6.1, 6.2, 8.11 – 8.1.6 (Text book 1)

Unit-II (2 Questions)

Markov Process: Semi Markov processes – Markov processes – Variation of M/M/1 queue – The G/M/1 queue – Uniformized Markov processes – The Chapman Kolmogrov differential equations.

Sections 8.3 – 8.8 (Text book 1)

Unit-III (2 Questions)

Matrix Geometric Solutions: Matrix geometric systems – General matrix geometric solutions – Matrix geometric solutions for Markov chains – Phase distributions.

Sections 9.1 – 9.3, 9.5 (Text book 1)

Unit-IV (2 Questions)

Numerical Solutions of Markov Chains with MATLAB: Non negative matrices – Non negative decomposable matrices – The theorem of PerronFrobenius– Iterative methods: The power method – Jacobi - Gauss Seidal – Successive Over Relaxation (SOR), symmetric SOR, and related MATLAB programs.

Sections 1.5, 3.1, 3.2 (Text book 2)

Text Books:

1. Probability, Stochastic Processes, and Queueing Theory, Randolph Nelson, Springer – Verlag.
2. Introduction to the Numerical Solutions of Markov Chains, William J. Stewart, Princeton University Press.

Board of Studies in Mathematics, Kakatiya University

~~168~~ ~~106~~
173

Chairperson
BoS in Mathematics
Kakatiya University,
Warangal 506

[redacted]

Text Books:

1. Reliability Engineering by L. S. Srinath, Fourth edition, East-West Press.
2. Reliability in Engineering Design by K.C.Kapur, L.R.Lamberson, John Wiley & Sons, Inc.
3. Reliability Engineering by E. Balagurusamy, Tata McGraw Hill publishing company Ltd

Board of Studies in Mathematics, Kakatiya University

Chairperson
BoS in Mathematics
Kakatiya University
Warangal 506

~~1702~~ 108
175