BHARATHIAR UNIVERSITY, COIMBATORE -641046

M.Phil./ Ph.D. Applied Mathematics

FT / PT with effective from 2009–10

Paper I : Research Methodology

Paper II : Computational Methods

Paper III : Special Paper (anyone of the following)

1. Heat Transfer and Magnetohydrodynamics.

2. Fuzzy Sets, Logic and Theory of Neural Networks.

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M.Phil. Applied Mathematics - FT / PT with effective from 2009–10

Paper-I : Research Methodology

UNIT I: Dimensional analysis and scaling

Dimensional analysis – The program of Applied Mathematics – Dimensional Methods – The Buckingham Pi theorem – Formulation – Application to a Diffusion Problem – Proof of the Pi theorem – Scaling – Characteristic Scales – A Chemical Reactor Problem – The Projectile Problem – Population Models.

UNIT II: Regular Perturbation Method

The Perturbation Method – Motion in a Nonlinear Resistive Medium – A Non linear Oscillator – The Poincare-Lindsted Method – Asymptotics.

UNIT III: Singular Perturbation and boundary-layer analysis

Failure of Regular Perturbation – Inner and outer approximations – Algebraic equations and Balancing – The inner approximation – Matching – Uniform approximations – Worked example – Boundary Layer Phenomena

UNIT – IV: WKB Approximation & Asymptotic Expansion of Integrals

The WKB Approximation - The Nonoscillatory Case - The Oscillatory Case. Asymptotic Expansion of Integrals - Laplace Integrals - Integration by parts - Generalizations.

UNIT – V:Wave Phenomena in Continuous Systems

Wave propagation - Waves - Linear Waves - Nonlinear Waves – Burgers' Equation - The Korteweg-deVries Equation.

Text book

J.David Logan "Applied Mathematics**",** Second Edition, John Wiley & Sons, Inc. (1997). (Relevant Sections Only)

Reference Books

1. A.H. Nayfeh, "Perturbation Methods", John Wiley & Sons, New York, (1973).
2. R. Bellman, "Perturbation Techniques in Mathematics, Physics & Engineering", Holt, Rinehart & Winston, Inc. New York. (1963).

Paper- II : Computational Methods

UNIT I: Finite Difference Method

Two-dimensional parabolic equations – Alternating Direction implicit method-The parabolic equation in cylindrical and in spherical polar co-ordinates – Miscellaneous methods for improving accuracy – Reduction of the local truncation error – Use of Three time –level difference equation – Solution of Non-linear parabolic equation – A three time-level method **.**

UNIT II: Finite Element Method for One Dimensional Stress Deformation

Local and global coordinate system for the One-Dimensional Problem-One-Dimensional Problem-Stress-Strain Relation-Principle of Minimum Potential Energy-Potential Energy Approach (for assembly)-Direct Stiffness Method-Boundary Conditions-Strains and Stresses-Formulation by Galerkin's Method-Complementary Energy Approach-Mixed Approach.

UNIT III: Finite Element Method for Two Dimensional Stress Deformation

Introduction-Plane Deformations-Plane Stress Idealization-Plane Strain Idealization-Axisymmetric Idealization-Strain-Displacement Relations-Finite Element Formulation-Requirements for Approximation Function-Plane Stress Idealization-Triangular element-Comment on convergence.

UNIT IV: The Finite Volume Method for Diffusion Problems

Summary of conservative form of the governing equations of fluid flow-Differential and integral forms of the general transport equations-Finite volume method for Diffusion problems-Introduction-Finite volume method for one dimensional steady state diffusion-worked examples-Finite volume method for two dimensional diffusion problems-Finite volume method for three dimensional diffusion problems.

UNIT V: The Finite Volume Method for Convection –Diffusion Problems

Introduction-steady one dimensional convection and diffusion-The central differencing scheme-Properties of discretization schemes-Assessment-The upwind differencing scheme-The hybrid Differencing scheme-Assessment-Higher Differencing scheme for multi dimensional convection diffusion-The power law scheme

Text book for Unit I

G.D.Smith, "Numerical Solution of Partial Differential Equations – Finite Difference Methods", Clarendon Press, Oxford, (1978). (Relevant Sections only)

Text book for Unit II & Unit III

C.S.Desai, "Elementary Finite Element Method" Prentice Hall, Inc. (1979). (Relevant Sections only)

Text book for Unit IV & Unit V

H.K.Versteey & W. Malalasekara, "An Introduction to CFD-The Finite Volume Method" Longman Scientific &Technical, England. (1995). (Relevant Sections only)

Reference Books:

1. T.J. Chung,"Computational Fluid Dynamics", Cambridge University Press, (2003).
2. Joel H. Ferzigen & Milovan Peric "Computational Methods for Fluid Dynamics", Springer, (2002).
3. J.N.Reddy, "An Introduction to the Finite Element Method", McGraw-Hill, (2005).

Paper - III : Special Paper

1. Heat Transfer and Magnetohydrodynamics

UNIT I: Flow along surfaces and in channels

Boundary layer and turbulence – The momentum equation of the boundary layer – The laminar-flow boundary-layer equation - The plane plate in longitudinal flow - Pressure gradients along a surface - Exact solutions of the laminar boundary-layer equations for a flat plate

UNIT II: Forced Convection in Laminar Flow

The heat-flow equation of the boundary layer – Laminar boundary-layer energy equation – The plane plate in longitudinal flow – The plane plate with arbitrarily varying wall temperature– Exact solutions of the laminar- boundary- layer energy equation – Flow through a tube.

UNIT III: Free Convection

Laminar heat transfer on a vertical plate and horizontal tube – Turbulent heat transfer on a vertical plate – Derivation of the boundary-layer equations – Free convection in a fluid enclosed between two plane walls – Mixed free and forced convection.

UNIT IV:Introduction and fundamental Equations of Magnetohydrodynamics and Steady Laminar motion

Introduction and fundamental equations: The electrodynamics of moving media-The electromagnetic effects and the magnetic Reynolds number-Alfven's theorem-
The magnetic energy-The mechanical Equations - The mechanical effects-The Electromagnetic stresses-Steady Laminar motion.

UNIT V: Magnetohydrodynamic waves and stability

Magnetohydrodynamic waves-Waves in an infinite fluid of infinite electrical conductivity-Alfven waves- Magnetohydrodynamic waves in a compressible fluid-Stability-Introduction—Simple illustrative examples-The Method of small Oscillations

Text book for Units I, II, III

E.R.G.Eckert & Robert M. Drake, **"**Heat and Mass Transfer" McGraw-Hill, Tokyo, (1979). (Relevant Sections only)

Textbook for Units IV & V

V.C.A Ferraro & C. Plumpton, **"**An Introduction to Magneto-Fluid Mechanics" Clanendon Press, Oxford, (1966). (Relevant Sections only)

Books for Reference:

1. B. Gebhart, "Heat Transfer", McGraw-Hill, NewYork, (1971).
2. H .Schlichiting, "Boundary Layer Theory", Mc Graw Hill, (1979).
3. Alan Jeffrey, "Magnetohydrodynamoics", Oliver & Boyd, London, (1966).

Paper - III : Special Paper

2. Fuzzy Sets, Logic and Theory of Neural Networks

Unit I: Fuzzy sets and Fuzzy relations

Fuzzy sets – Basic types and basic concepts – Properties of α-cuts – Representations of fuzzy sets – Decomposition Theorems – Extension principle for fuzzy sets . Crisp and fuzzy relations – Projections and cylindric extensions – Binary fuzzy relations – Binary relations on a single set – Fuzzy equivalence relations – Fuzzy compatibility relations – Fuzzy ordering relations – Fuzzy Morphisms – Sup-i compositions of fuzzy relations. Inf-w_i compositions of fuzzy relations.

Unit II: Fuzzy Relation Equations

Introduction- Problem Partitioning-Solution Method-Fuzzy Relation Equations Based on Sup-i Compositions-Fuzzy Relation Equations Based on Inf-w_i Compositions-Approximate Solutions- The Use of Neural Networks.

Unit III: Fuzzy Logic

Introduction – Fuzzy Propositions – Fuzzy Quantifiers – Linguistic Hedges – Inference from Conditional Fuzzy Propositions – Inference from Conditional and Qualified Propositions – Inference from Quantified Propositions.

Unit IV: Fuzzy Control

Origin and Objective-Automatic Control-The Fuzzy Controllers., Types of Fuzzy Controllers-The Mamdani Controller- Defuzzification-The Sugeno Controller., Design Parameters-Scaling Factors-Fuzzy Sets-Rules-Adaptive Fuzzy Control-Applications.

Unit V: Neural Network Theory

Neuronal Dynamics : Activations and Signals –Neurons As Functions-Signal Monotonicity-Biological Activations and Signals-Competitive Neuronal Signals-Neuron Fields-Neuronal Dynamical Systems-Common Signal Functions-Pulse-Coded Signal Functions. Activations Models- Neuronal Dynamical Systems-Additive Neuronal Dynamics-Additive Neuronal Feedback-Additive Activation Models- Additive Bivalent Models.-Bivalent Additive BAM-Bidirectional Stability-Lyapunov Functions- Bivalent BAM Theorem.

Text Book for Units I, II & III

Klir G.J and Yaun Bo “Fuzzy sets and fuzzy logic: Theory and applications”, Prentice Hall of India, New Delhi, (2002). (Relevant Sections only)

Text Book for Unit IV

Zimmermann H.J., “Fuzzy Set Theory and its Applications”, Fourth Edition, Kluwer Academic Publishers, London,(2001). (Relevant Sections only)

Text Book for Unit V

Bart Kosko, "Neural Networks and Fuzzy Systems", Prentice Hall of India, New Delhi, (2001). (Relevant Sections only)

Reference Books:

1 Kaufmann "Introduction to the theory of fuzzy sets", Volume 1 -, Academic Press, Inc., Orlando, Florida,(1973).

2. John N. Moderson and Premchand S. Nair., "Fuzzy Mathematics: An introduction for Engineers and Scientists", – Physica Verlag, Heidelberg, Germany, (1998).

3. S.Rajasekaran and G.A. Vijayalakshmi Pai., "Neural Networks, Fuzzy Logic and Genetic Algorithms Synthesis and Applications". Prentice-Hall of India, New Delhi,(2004).

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