Bharathiar University, Coimbatore-641 046
M.Phil Mathematics FT/PT Effective from 2006 - 2007
Paper I – Research Methodology

Unit I: Bounded Linear Operators

Uniformly continuous semigroups of bounded linear operators – Strongly continuous semigroups of bounded linear operators – The Hille-Yosida theorem – The Lumer Phillips theorem.

Unit II: Infinitesimal Generators and Semigroups

The characterization of the infinitesimal generators of C_0 semigroups – Groups of bounded operators – The inversion of the Laplace transform – Two exponential formulas.

Unit III: Spectral Theory

Weak equals strong – Spectral mapping theorem – Semigroups of compact operators –Differentiability - Analytic semigroups.

Unit IV: Fundamental Group

Homotopy of Paths - Fundamental Group - Covering spaces – Fundamental Groups of the Circle and S^n.

Unit V: Separation Theorems in the Plane

Jordan Separation Theorem – Invariance of Domain – Jordan curve theorem.

Treatment as in:

A.PAZY, Semigroups of Linear Operators and Applications to Partial Diffential Equations, Springer-Verlag, New york, 1983.

Unit I: Chapter 1 Sections 1.1 – 1.4
Unit II: Chapter 1 Sections 1.5 – 1.8
Unit III: Chapter 2 Sections 2.1 – 2.5

J.R.Munkers, Topology, 2nd Edition, Pearson Education (Singapore) P. Ltd., 2000.

Unit IV: Chapter 9 Sections 51.54, 57 & 59
Unit V: Chapter 10 Sections 61 – 63.

References:

1. A.V.Balakrishnan, Applied Functional Analysis, Springer-Verlag, New York, 1976.
2. J.A.Goldstein, Semigroups of Linear Operators and Applications, Oxford University press, New York, 1985.
3. J.Dugundji, Topology, Allyn and Bacon, Boston, 1966.
4. W.S.Massey, Algebraic Topology-An Introduction, Springer-Verlag, New York, 1976.

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Paper II – Mathematical Methods

UNIT I: Elementary Fixed Point Theorems

Fixed point spaces – Forming new fixed point spaces from old – Topological transversality – Factorization technique – Banach contraction principle – Elementary domain invariance – Continuation method for contractive maps – Nonlinear alternative for contractive maps – Extensions of the Banach theorem – Miscellaneous results and examples.

UNIT II: Fixed Points for Compact Maps in Normed Linear Spaces

Compact and completely continuous operators – Schauder projection and approximation theorem – Extension of the Brouwer and Borsuk theorems – Topological transversality. Existence of essential maps – Equation $x = F(x)$. The Leray-Schauder principle – Equation $x = \lambda F(x)$. Birkhoff-Kellogg theorem – Compact fields – Equation $y = x - F(x)$. Invariance of domain – Miscellaneous results and examples.

Treatment as in: A.Granas and J.Dugundji, Fixed Point Theory, Springer, 2003.
Unit I: Chapter 0: Sections 1-4 and Chapter1:Sections 1-6.
Unit II: Chapter 6: Sections 1-9.

UNIT III: Perturbation Methods

Parameter Perturbations – An algebraic equation – The Van der pol oscillator – Coordinate perturbations – Bessel equation of zeroth order – A simple example – Order symbols and Gauge functions - Asymptotic series – Asymptotic expansions - Uniqueness of Asymptotic expansions – Convergent versus asymptotic series – Nonuniform expansions – Elementary operations on asymptotic expansions – Straight forward expansions and sources of Nonuniformity – Infinite domains - The Duffing equation – A model for weak nonlinear instability – A small parameter multiplying the highest derivative – A second order example – Relaxation osicillations – Type change of a partial differential equation - A simple example – The presence of singularities – Shift in singularity – The earth-moon- spaceship problem – The role of coordinate systems - The method of strained parameters – The Lindstedt-Poincare Method – transition curves for the Mathieu equation – Lighthill's Technique – A first-order differential equation.

Treatment as in "Perturbation Methods" by A.H.Nayfeh, Jhon Wiley & Sons, New York, 1973.

Chapter 1 (Sections 1.1-1.7)
Chapter 2 (sections 2.1.1, 2.1.2, 2.2.1, 2.2.3, 2.3.1, 2.4.1, 2.4.2 & 2.5)
Chapter 3 (Sections 3.1.1, 3.1.2, 3.2.1)

UNIT IV: Finite Element Methods

Finite elements - line segment element - Triangular element - Linear Lagrange polynomial - Numerical Integration over finite element - Finite element methods - Ritz finite element method - Least square finite element method - Galerkin finite element method - Convergence analysis - Boundary value Problems in ordinary differential equations - Assembly of element equations - Mixed Boundary Conditions - Galerkin method.

Treatment as in:

"Numerical Solution of Differential Equations" - By M.K.Jain, New Age International (p) Limited, New Delhi, 2002.

Chapter 8 (Relevant sections only from sections 8.4, 8.5&8.6)

UNIT V: Finite Volume Method

Finite volume method for Diffusion Problems: 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 – Summary of discretised equations for Diffusion problems.

Finite volume method for Convection-Diffusion Problems: Steady one-dimensional convection and diffusion – The central differencing schemes.

Treatment as in:

"An Introduction to Computational Fluid Dynamics – The Finite Volume Method" by H.K.Versteeg and W.Malalasekera, Longman Scientific & Technical, England, 1995.

Chapter 4

Chapter 5 (Sections 5.1 – 5.4)

Reference:

"Numerical Heat Transfer And Fluid Flow" by S.V.Patankar, Hemisphere Publishing Corporation, New York, 1980.