ITEM NO. FS 13.04(1)

ANNA UNIVERSITY CHENNAI :: CHENNAI-600 025

M.Phil. (MATHEMATICS)

FIRST SEMESTER

Course No.	Course Title	L	T	P	C
MA911	Research Methodology	4	0	0	4
MA912	Advanced Analysis And Differential Equations	4	0	0	4
	ELECTIVE I	4	0	0	4
	ELECTIVE II	4	0	0	4

SECOND SEMESTER

Course No.	Course Title	L	T	P	C
MA921	SEMINAR	1	0	0	10
MA922	PROJECT	0	0	32	16

ELECTIVES

Sl. No.	Course Code	Course Title	L	T	P	C
1.	MA951	Commutative Algebra	4	0	0	4
2.	MA952	Analysis	4	0	0	4
3.	MA953	Continuum Mechanics	4	0	0	4
4.	MA954	Number Theory	4	0	0	4
5.	MA955	Advanced Number Theory	4	0	0	4
6.	MA956	Formal Languages and Automata Theory	4	0	0	4
7.	MA957	Algebraic Theory of Semigroups	4	0	0	4
8.	MA958	Cryptography	4	0	0	4
9.	MA959	Molecular Computing	4	0	0	4
10.	MA960	Operator Algebras	4	0	0	4
11.	MA961	Operations Research	4	0	0	4
12.	MA962	Heat and Mass Transfer	4	0	0	4
13.	MA963	Computational Fluid Dynamics	4	0	0	4
14.	MA964	Orbital Mechanics	4	0	0	4
15.	MA965	Finite Element Analysis	4	0	0	4
16.	MA966	Space Geometry and Satellite Tracking	4	0	0	4
17.	MA967	Boundary Layer Flows	4	0	0	4
18.	MA968	Generalized Inverses	4	0	0	4
19.	MA969	Graph Theory	4	0	0	4
20.	MA970	Advanced Graph Theory	4	0	0	4
21.	MA971	Special Functions	4	0	0	4
22.	MA972	Basic Hypergeometric Series	4	0	0	4
23.	MA973	Univalent Functions	4	0	0	4
24.	MA974	Fundamentals of Chemical Graph Theory	4	0	0	4
25.	MA975	Functional Analysis and Applications to Partial Differential Equations	4	0	0	4

Total Credits to be earned for the award of M.Phil Degree : 33

MA911 RESEARCH METHODOLOGY L T P C
4 0 0 4

UNIT I TECHNICAL REPORT PREPARATION 9

Structure – Planning the report – Writing and revising the first draft – Diagrams, graphs, tables and mathematics – Report layout – Finalising the report and proof reading – Originality and Plagiarism – Power point presentation – Document preparation using LaTex.

UNIT II NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 13

Existence and Uniqueness of solutions – Single Step Methods : Euler's method – Taylor series method – Runge-Kutta method of second and fourth order – Multistep methods: Adams-Bashforth and Milne's methods – Local, Global errors and Stability considerations – Linear Two point Boundary Value Problems: Shooting methods and Finite Difference method.

UNIT III NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS 13

Parabolic Equations: Explicit and Implicit Methods – Stability considerations; Elliptic equations: Finite difference and Galerkin Methods – truncation error; Hyperbolic equation: First Order and Quasilinear second order – method of Characteristics - Explicit scheme.

UNIT IV ESTIMATION THEORY AND TESTING OF HYPOTHESIS 13

Characteristics of good estimators – Method of moments – Maximum Likelihood estimates – Sampling distributions **-** Type I and Type II errors - Tests based on Normal, t, χ^2 and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit.

UNIT V DESIGN OF EXPERIMENTS 12

Analysis of Variance – One-way and two-way Classifications – Completely Randomized Design – Randomized Block Design – Latin Square Design – Analysis of covariance.

Total: 60 Periods

BOOKS FOR REFERENCE:

1. Eisenberg, A, "Effective Technical Communication", McGraw Hill, 1992.
2. MLA Handbook for Writers of Research Papers, 6th edition, Affiliated East West, New Delhi, 2003.
3. Kopka, H and Daly, P.W, "A Guide to LaTex 2E", Addison-Wesley Publishers Ltd, 1995.
4. Kincaid D. and Chenney W., "Numerical Analysis: Mathematics of Scientific Computing", Brooks/Cole Pub. 2nd Edition, 2002.
5. Isaacson E. and Keller, H.B., "Analysis of Numerical Methods" Dover Publication, 1994.
6. Johnson,J.A and Gupta,C.B, "Miller & Freund's Probability and Statistics for Engineers", Pearson Education Asia, 2006.
7. Walpole,R.E, Myers,R.H, Myers,S.L and Ye,K, "Probability and Statistics for Engineers and Scientists", Pearson Education Asia, 2002.

MA912 ADVANCED ANALYSIS AND DIFFERNTIAL EQUATIONS

L T P C
4 0 0 4

UNIT – I NORMED SPACES 12

Vector space – Normed space - Banach space – Properties of normed spaces – Finite dimentional normed spaces and subspaces – Compactness and finite dimension – Linear operators – Bounded and continuous linear operators – Linear functionals – Linear operators and functionals on finite dimensional spaces – Normed spaces of operators – Dual space.

UNIT – II INNER PRODUCT SPACES 12

Inner product space - Hilbert space – Properties of inner product spaces – Orthogonal complements and direct sums – Orthonormal sets and sequences – Series related to orthonormal sequences and sets – Total orthonormal sets and sequences – Representation of functionals on Hilbert spaces – Hilbert adjoint operator – Self-adjoint, Unitary and Normal operators.

UNIT–III FUNCTIONS OF ONE COMPLEX VARIABLE 12

Analytic Functions – Cauchy's Theorem – Calculus of residues – Applications to Real Integrals – Entire Functions – Riemann Zeta Functions – Conformal Mapping – Riemann Mapping Theorem.

UNIT – IV NON-LINEAR ORDINARY DIFFERENTIAL EQUATIONS 12

Introduction – Solvable for x,y and p – Equations with separable variables – Equations reduced to linear form – Bernoulli's equation – Riccatti's equation – Special form of Riccatti's equation – Non-linear pendulum – Duffing's equation.

UNIT – V SOLUTION OF BOUNDARY VALUE PROBLEMS USING INTEGRAL TRANSFORMS TECHNIQUES 12

Solution of partial differential equations – Diffusion equation – Wave equation – Laplace equation – using Laplace and Fourier Transforms methods.

L: 60

REFERENCES:

1. Erwin Kreysig, Introductory Functional Analysis with Applications, John Wiley, 1978.
2. Stephenson, G.Radmore, D.M., Advanced Mathematical Methods for Engineering and Science Students, Cambridge University Press, 1990.
3. Sankara Roa, K., Introduction to Partial Differential Equations, Prentice – Hall of India Private Ltd, 1995.
4. Bondy, J.A., Murthy, U.S.R., Graph Theory with Applications, Mac Millan, 1997.
5. Limaye, B.V., Functional Analysis, Second Edition, New Age International Ltd., Publishers, 1996.
6. Sneddon, I.N., The use of Integral Transforms, Tata Mc-Graw Hill, 1974.

MA951 COMMUTATIVE ALGEBRA

L T P C
4 0 0 4

UNIT – I RINGS 6

Rings and ring homomorphisms – ideals – quotient rings – zero divisors.

UNIT – II IDEALS 11

Prime ideals and Maximal ideals – Nilradical and Jacobson Radical – Operation on Ideals – Extension and contraction.

UNIT – III MODULES 17

Module and Module homomorphism – submodules – quotient modules – operations on submodules – direct sum and product – finitely generated modules – exact sequences.

UNIT – IV RINGS AND MODULES OF FRACTIONS 17

Local properties – Extended and contracted ideals in rings of fractions – Primary decomposition – Chain conditions – Noetherian rings.

UNIT – V ARTIN RINGS 9

Discrete valuation rings and Dedekind domains – fractional ideals.

L: 60

REFERENCES:

1. Atiyah and Macdonald , Introduction to Commutative Algebra, Addison Wesley, 1969
2. Serge Lang, Algebra , Addisaon Wesley , 3rd Edition, 2005.
3. Pierce, Associative Algebras ,Springer Verlag , N.Y 1982.
4. Gert-Martin and Gerhard P. Fisher, Bachmann.D, Lossen.C, A Singular Introduction to Commutative Algebra, 2002.

MA952 ANALYSIS

L T P C
4 0 0 4

UNIT – I ABSTRACT INTEGRATION 16

The concept of measurability – Simple functions – Elementary properties of measures – Integration of positive functions – Integration of complex functions – The role played by the sets of measure zero.

UNIT – II POSITIVE BOREL MEASURES 12

Topological preliminaries – The Riesz representation theorem – Regularity properties of Borel measures – Lebesgue measure – Continuity properties of measurable functions.

UNIT – III L^P - SPACES 8

Convex functions and inequalities – The L^p spaces – Approximation by continuous functions.

UNIT – IV BANACH SPACE TECHNIQUES 12

Banach spaces – Consequences of Baire's theorem – Fourier series of continuous functions – Fourier coefficients of L^1 functions – The Hahn – Banach theory - An abstract approach to the Poisson integral.

UNIT – V FOURIER TRANSFORMS 12

Formal properties – The inversion theorem – The Plancheral Theorem - The Banach algebra L^1.

L: 60

REFERENCES:

1. Rudin, W. Real and Complex Analysis, Tata Mc-Graw Hill (1987)
2. Halmos, P.R. Measure Theory, D. Van Nostrand Company Inc.,Princeton, N. J., 1950.
3. Royden, H.L., Real Analysis, The Macmillan company, New York, 1962.
4. Hewitt, E., Ross, K.A., Abstract Harmmonic Analysis, Springer-Verlag, Berlin, Vol. I , 1963, Vol II, 1970.
5. Elras, M. Stein, Ramishakarchi, Complex Analysis, Prinson University Press, 2003.

MA953 CONTINUUM MECHANICS L T PC
4 0 0 4

UNIT – I STRESS ANALYSIS 12

Continuous Medium Review of vector and tensor analysis – Body and surface forces – Stress vector – Principal axes – Invariants.

UNIT – II STRAIN AND DEFORMATION 12

Small strain – Material derivatives – Stretch – Vorticity – Geometric measures – Compatibility conditions.

UNIT – III GENERAL PRINCIPLES AND CONSTITUTIVE EQUATIONS 12

General principles – Mass equation – Momentum principles – Energy balance – First law of thermodynamics – Energy equation – Ideal materials – Hooke's law – Isotropy – Strain energy function.

UNIT – IV FLUID MECHANICS 12

Navier- Stoke's equation – Flow between parallel plates – Euler's equation - Kelvin's theorem – Bernoulli's theorem – Velocity potential – Flow of an incompressible perfect fluid.

UNIT – V LINEARIZED THEORY OF ELASTICITY 12

Field equations – Plane elasticity in rectangular coordinates.

L : 60

BOOK FOR STUDY:

1. Malvern, L.E., Introduction to the Mechanics of a Continuous Medium, Prentice – Hall, 1969.

REFERENCES:

1. Eringen,A.S., Mechanics of Continua, John Wiley, 1965.
2. Chandrasekharaiah,D.S., Lokenath Debnath, Continuum Mechanics, Academic Press, 1994.

MA954 **NUMBER THEORY** **L T P C**
4 0 0 4

UNIT – I CONGRUENCES **5**
Congruences, Solutions of congruences, congruences of deg 1, The function 0(n).

UNIT – II CONGRUENCES OF HIGHER DEGREE **12**
Congruences of higher degree, Prime power moduli, Prime modulus, congruences of degree 2, Prime modulus, Power residues.

UNIT – III QUADRATIC RESIDUES **17**
Quadratic residues, Quadratic reciprocity, The Jacobi symbol, greatest integer function, arithmetic function, The Moebius Inversion formula, The multiplication of arithmetic functions.

UNIT – IV DIOPHANTINE EQUATIONS **17**
Diophantine equations, The equation ax + by = c, Positive solutions, Other linear Equations, Sums of four and five squares, warings problem, sum of fourth powers, sum of two Squares.

UNIT – V PARTITIONS **9**
Partitions, graphs, formal power series and Euler's identity – Euler's formula.

L: 60

BOOK FOR STUDY:

1. Ivan Niven, Herbert S.Zuckermann, Hugh L.Montgomery, An Introduction to The Theory of Numbers, John Wiley, 5th Edition 2006.

REFERENCES:

1. Tom M. Apostol, Introduction to analytic number theory, Narosa Publishing House, 1980.
2. Rose,H.E., A Course in Number Theory, Second Edition, Clarendon Press, 1995.
3. Kenneth Ireland & Michael Rosen, A Classical Introduction to Modern Number Theory, Second Edition, Springer International Edition, 2004.

MA955 **ADVANCED NUMBER THEORY**

L T P C
4 0 0 4

UNIT – I CONTINUED FRACTIONS **12**
The Euclidean Algorithm – Uniqueness – Infinite Continued Fractions – Irrational Numbers – Approximations to Irrational Numbers – Best Possible Approximations – Periodic Continued Fractions – Pell's Equation – Numerical Computation**.**

UNIT – II PRIMES AND MULTIPLICATIVE NUMBER THEORY **12**
Elementary Prime Number Estimates – Dirichlet Series – Estimates of Arithmetic Functions – Primes in Arithmetic Progressions.

UNIT – III ALGEBRAIC NUMBERS **12**
Polynomials – Algebraic Numbers – Algebraic Number Fields – Algebraic Integers – Quadratic Fields – Units in Quadratic Fields – Primes in Quadratic Fields – Unique Factorization – Primes in Quadratic Fields Having the Unique Factorization Property – the Equation $x^3 + y^3 = z^3$.

UNIT – IV THE PARTITION FUNCTION 12

Partitions – Ferrers Graphs – Formal Power Series, Generating Functions and Euler's Identity – Euler's Formula; Bounds on $p(n)$ - Jacobi's Formula – A Divisibility Property.

UNIT – V DENSITY OF SEQUENCES OF INTEGERS 12

Asympotic Density – Schnirelmann Density and the $\alpha\,\beta$ Theorem.

L : 60

BOOK FOR STUDY:

1. Ivan Niven, Herbert S.Zuckermann, Hugh L.Montgomery, An Introduction to The Theory of Numbers, John Wiley, 5th Edition 2006.

REFERENCES:

1. Tom M. Apostol, Introduction to analytic number theory, Narosa Publishing House, 1980.
2. Rose,H.E., A Course in Number Theory, Second Edition, Clarendon Press, 1995.
3. Kenneth Ireland & Michael Rosen, A Classical Introduction to Modern Number Theory, Second Edition, Springer International Edition, 2004.

MA956 FORMAL LANGUAGES AND AUTOMATA THEORY

L T P C
4 0 0 4

UNIT – I REGULAR SETS AND FINITE STATE AUTOMATA 12

Finite state automata – Deterministic and non-deterministic model – languages accepted by Finite State Automata – pumping Lemma for regular set.

UNIT – II CONTEXT FREE LANGUAGES 12

Grammar **–** Context Free Grammars – Derivation trees – Simplification of context-Free grammar – Chomsky normal Form – Griebach Normal Form.

UNIT – III PUSH DOWN AUTOMATA AND PROPERTIES AND CONTEXT FREE LANGUAGES 12

Pushdown automata – Push down automata and Context Free Languages – Pumping lemma for context free languages.

UNIT – IV TURING MACHINE AND UNDECIDABILITY 12

Turing Machine model – Computational languages and functions – Modifications of Turing machines – Properties of recursive and recursively enumerable languages – Universal Turing Machine and the undecidable problem.

UNIT – V THE CHOMSKY HIERARCHY 12

Regular grammar – Unrestricted grammar – Context Sensitive languages – Linear bounded automata – Relation between classes of languages.

L : 60

BOOK FOR STUDY:

1. Hopcroft J.E., and Ullman J.D., Introduction to Automata, Languages and Computation, Narosa Publishing House, 1987.

REFERENCES:

1. Hopcroft, J.E., Rajeev Motwani and Ullman, J.D., Introduction to Automata Theory Languages and Computation, Third Edition, Addison Wesley, 2006.
2. Mishra, K.L.P and Chandrasekaran.N., Theory of Computation, Second Edition, Prentice Hall of India, 2003.
3. Peter Linz, An Introduction to Formal Languages and Automata, Third Edition, Narosa Publishing House, 2003.

MA957 ALGEBRAIC THEORY OF SEMIGROUPS L T P C
4 0 0 4

UNIT – I SEMIGROUPS 12

Monogenic semigroups – Ordered sets, semilattices and lattices Binary relations, equivalences – Congruences – Free semigroups – Ideals and Rees congruences. The equivalence L,R,H,J and D – The structure of D classes – Regular D-classes – Regular semigroups.

UNIT – II SIMPLE SEMIGROUPS 12

Certain classes of semigroups – O-Simple semigroups – Principal factors – Primitive Idempotents – Congruences on completely simple O – semigroups.

UNIT – III BANDS 12

Union of groups – semilattice of groups – bands – free bands – varieties of bands.

UNIT – IV INVERSE SEMIGROUPS AND SIMPLE INVERSE SEMIGROUPS 12

Inverse semigroups – Natural order relation on an inverse semi group – Congruence in Inverse semigroup – Bisimple inverse semigroups – Simple inverse semigroups.

UNIT – V SEMI LATTICES 12

Fundamental inverse semigroups – autouniform semi lattices.

L : 60

BOOK FOR STUDY:

1. Howie, J.M., An Introduction to Semigroup Theory, Academic Press-1976.

REFERENCES:

1. John. M. Howie, London Mathematical Society Monographs New Series, Fundamentals of Semigroup Theory, Oxford Science Publications, 1996.
2. Gerhard O. Michler, Theory of Finite Simple Groups, University Press, Cambridge, 2006.

MA958 CRYPTOGRAPHY

L T P C
4 0 0 4

UNIT – I MATHEMATICS OF CRYPTOGRAPHY 12

Modular Arithmetic – Matrices – Linear Congruences – Galois Fields – Primes – Generating Primes – Primality Technique – Factorization – Quadratic Congruences – Exponentiation and Logarithm.

UNIT – II TRADITION SYMMETRIC – KEY CIPHERS 12

Substitution Ciphers – Transportation Ciphers – Steam and Block Ciphers – Modern Block Ciphers – Modern Steam Ciphers – DES – AES.

UNIT – III ASYMMETRIC KEY CRYPTOGRAPHY 12

RSA Cryptosystem – Rabin Cryptosystem – Elgamal Cryptosystem – Elliptic Curve Cryptosystem.

UNIT – IV MESSAGE INTEGRITY AND AUTHENTICATION 12

Documents – Finger prints – Message and Message Digest – Checking Integrity – Random Oracle Model – Message Authentication – Message Authentication Code (MAC) – Hash Functions – SHA512 – WHIRLPOOL Cipher.

UNIT – V SIGNATURE SCHEMES 12

Attacks on Digital Signature – RSA Digital Signature Scheme – Elgamal DSS – Schnorr DSS – Elliptic Curve DSS – Variations and Applications – Key Management – KDC – Session Keys.

L : 60

BOOK FOR STUDY:

1. Behrouz A. Forouzan, Cryptography & Network Security, Tata McGraw Hill, Special Indian Edition, 2007.

REFERENCES:

1. Koblitz, N., A course in number theory and Cryptography, Springer Verlag 1988.
2. Stinson, D.R., Cryptography: Theory and Practice, CRC Press, 1955.

MA959 MOLECULAR COMPUTING L T P C
4 0 0 4

UNIT – I BIOLOGICAL INTRODUCTION (DNA STRUCTURE AND PROCESSING) 12

Structure of DNA – Operations on DNA molecules – Reading out the sequence.

UNIT – II BEGINNINGS OF MOLECULAR COMPUTING 12

Adleman's experiment – SAT problem – Breaking DES code.

UNIT – III REPRESENTATION OF LANGUAGES 12

Representations of Regular and Linear Languages – Characterizations of Recursively Enumerable Languages.

UNIT – IV STICKER SYSTEM AND SPLICING SYSTEM 12

Operations of Sticking – Sticker systems classifications – Generative capacity of Sticker System – Operations of Splicing – Non-Iterated Splicing as an operation with Languages – Iterated Splicing as an operation with Languages.

UNIT – V APPLICATIONS OF MOLECULAR COMPUTING 12

Recent applications of Molecular Computing to various problems of Mathematics and Theoretical Computer Science.

L : 60

BOOK FOR STUDY:

1. Rozenberg, DNA Computing, Springer Verlag, 1997.

REFERENCES:

1. Adleman, L.M., PWK Rothemund, Roweis, S. and Winfree, E., On applying molecular computation to the data Encryption standard, in proceedings of the 2nd DIMACS Workshop on DNA based computers, 1996.
2. Pisanti, N. A Survey of DNA Computing, Technical Report TR-97-07, University of Pisa, April, 1997.

MA960 OPERATOR ALGEBRAS

L T P C
4 0 0 4

UNIT – I NORMED SPACES 12

Vector Spaces – Normed spaces – Linear operators – The Hahn Banach Theorem – Completeness – Some topological considerations – Inner product Spaces – The Adjoint operators – Strong and weak convergence.

UNIT – II C* ALGEBRAS 12

Banach Algebras – Gelfand – Naim theory – Commutative C* Algebras.

UNIT – III REPRESENTATIONS OF C* ALGEBRAS 12

Representation of a unital C* algebra – Commutant – Von – Newmann's density theorem – GNS construction.

UNIT – IV OPERATOR THEORY 12

The Spectral theorem – polar decomposition – Compact operators.

UNIT – V UNBOUNDED OPERATORS 12

Closed operators – Symmetric and Self-adjoint operators – Spectral theorem and polar decomposition.

L : 60

BOOK FOR STUDY:

1. Sunder, V.S., Functional Analysis Spectral Theory, Hindustan Book Agency, Texts and readings in Mathematics (Trim series) Number 13,1997.

REFERENCES:

1. Arveson, W., An Invitation to C* Algebra GTM 39, Springer Verlag, 1976.
2. Davidson, K.R., C* Algebra's by examples (Trim series) Number 11, 1996.
3. Simmons, G.F., An Introduction to Topology and Modern Analysis, McGraw-Hill International Editions, 1963.

MA961 OPERATIONS RESEARCH

L T P C
4 0 0 4

UNIT – I LINEAR PROGRAMMING METHODS 12

Revised simplex method – dual simplex method – Interior point methods- Applications.

UNIT – II COMPUTATIONAL ASPECTS OF LINEAR PROGRAMMING 12

Redundancy – Problem dimension reduction algorithm – Constraint selection technique – Fuzzy linear programming- Applications.

UNIT – III NON-LINEAR PROGRAMMING PROBLEMS 12

Quadratic, Separable, Linear complementary, Fractional Linear Programming Problems- Applications.

UNIT – IV QUEUEING MODELS 12

General concepts – Markovian queues-single, Multi-Channel Models, Non-Markovian models – M/G/1 queue - Applications.

UNIT – V SIMULATION **12**

Monte-Carlo Simulation – Generation of Pseudo random numbers – Test for randomness – Generating random variates for probability distributions – Applications to simple problems in operations research.

L : 60

BOOKS FOR STUDY:

1. Hamdy A.Taha, Operations Research-An Introduction, Prentice Hall of India Pvt. Ltd., New Delhi, 7th Edition, 2005.
2. Geoffray Gordon, Systems Simulation, 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 1978.

REFERENCES:

1. Mokhtar, S. Bazara, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, 2nd Edition, John Wiley & Sons Inc. Singapore, 1990.
2. Mokhtar, S. Bazara, Hanif D. Sherali and Shetty,C.M., Non-linear Programming-Theory and Algorithms, 2nd Edition, John Wiley & Sons Inc Singapore, 1993.
3. Harvey M. Wagner, Principles of Operations Research with Applications to Managerial Decisions, 2nd Edition, Prentice-Hall of India Pvt. Ltd., New Delhi, 1975.

MA962 HEAT AND MASS TRANSFER **L T P C**
4 0 0 4

UNIT – I HEAT CONDUCTION **12**

1D Heat conduction - 2D steady state heat conduction – 2D un-steady heat conduction – Numerical solutions of 1D and 2D conduction equations.

UNIT – II FLOW ALONG SURFACES AND IN CHANNELS **12**

Boundary layers and turbulence – momentum equation- laminar flow boundary layer equation- plane plate in longitudinal flow – pressure gradients along a surface – exact solutions for a flat plate.

UNIT – III FREE CONVECTION **12**

Laminar heat transfer on a vertical plate and horizontal tube – turbulent heat transfer on a vertical plate – free convection in a fluid enclosed between two plane walls – mixed free and forced convection.

UNIT – IV FORCED CONVECTION IN LAMINAR FLOW **12**

Heat flow equation – energy equation – plane plate in longitudinal flow – arbitrarily varying wall temperature – exact solutions of energy equation.

UNIT – V MASS TRANSFER **12**

Diffusion – flat plate with heat and mass transfer – integrated boundary layer equations of mass transfer – similarity relations for mass transfer – evaporation of water into air.

L : 60

BOOKS FOR STUDY:

1. Eckert,E.R.G., and Drake,R.M., Heat and mass transfer , Tata McGraw Hill Publishing Co., 2nd Edition, 1979.
2. Cengel,Y.A., Heat Transfer, Mc Graw Hill, 2nd Edition, 2003.

REFERENCES:

1. Gebhart.B, Heat transfer , McGraw Hill Publishing Co., New York , 1971.
2. Schlichting.H, Boundary Layer Theory, McGraw Hill Publishing Co., 2nd Edition, 1979.

MA963 COMPUTATIONAL FLUID DYNAMICS

L T P C
4 0 0 4

UNIT – I GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD 12

Classification, Initial and Boundary Conditions, Initial and Boundary Value Problems – Finite Difference Method, Central, Forward, Backward differences – Uniform and non-Uniform grids - Numerical errors and Stability – Grid Independence Test.

UNIT – II GRIDS WITH APPROPRIATE TRANSFORMATIONS 12

Introduction – General transformation of equations – Metrics and Jacobians – Stretched grids – Boundary fitted coordinate systems – adaptive grids – staggered grids – Grid generation : physical aspects – by PDE solution – by algebraic mapping.

UNIT – III INVISCID FLOW 12

Basic Fluid dynamics equations in both inviscid and viscous flows – Panel method - Elements of 2D- and 3D- panels, panel singularities, Application of panel method to inviscid, incompressible and compressible flows.

UNIT – IV CONVECTION HEAT TRANSFER AND FEM 12

Steady, Unsteady 1-D & 2-D Convection-Diffusion – Introduction to FEM – Solution of steady heat conduction by FEM – Simulation by FEM.

UNIT – V THE FINITE VOLUME METHOD FOR CONVECTION-DIFFUSION PROBLEMS 12

Introduction – Steady 1-D Convection and Diffusion - Central Differencing Scheme – Properties of discretisation scheme – Upwind difference scheme – Hybrid differencing scheme – power-law scheme.

L: 60

BOOKS FOR STUDY:

1. Fletcher,C.A.J., Computational Techniques for Fluid Dynamics, Vol 2,1991.
2. Anderson.J.D., Computational Fluid Dynamics : The basics with application, McGraw Hill, 1995.

REFERENCES:

1. Ghoshdaddidar.P.S., Computer simulation of flow and heat transfer, Tata McGraw- Hill Publishing Company Ltd., 1998.
2. Versteeg.H.K., & Malalasekera.W., Fluid Dynamics: Finite Volume Method,1995.
3. Reddy.J.N., An Introduction to Finite Element Method, Second Edition, McGraw Hill, New York, 1993.

MA964 ORBITAL MECHANICS

L T P C
4 0 0 4

UNIT – I INTRODUCTORY ASTRODYNAMICS 12

Basics of Orbital Mechanics-Geometry and types of satellite orbits- Kepler's and Newton's Laws-Euler's angels-Two-Body Problem-Kepler's Time Equation - Time - Ephemeris Time - Atomic Time - Sidereal Time and Universal Time - Coordinate system in General - Celestial and Terrestrial Coordinate systems.

UNIT – II ORBITAL PERTURBATIONS 12

Prediction of Unperturbed Satellite Orbits - Geopotential and gravity Models – Luni-Solar Attraction - Solar Radiation Pressure - Atmospheric drag and density models - Thrust forces - Precision Modeling of Earth Tides, Empirical forces and Relativistic Effects.

UNIT – III ORBIT MANEUVERS 12

Introduction - Single Impulse Orbit adjustment - Multiple Orbit Adjustment -Hohmann Transfers- GTO-to-GEO Transfers - Geostationary Orbit corrections.

UNIT – IV NUMERICAL INTEGRATION 12

Runge-Kutta Methods – Multi-step Methods – Stoemer and Cowell Methods - Extrapolation Methods – Comparison of Integration methods

UNIT – V ORBIT DETERMINATION AND PARAMETER ESTIMATION 12

Weighted Least Squares Estimation - Numerical Solution of Least - Squares Problems- Kalman Filtering - Extended Kalman Filtering - Comparison of Batch and Sequential Estimation.

L : 60

BOOKS FOR STUDY:

1. Oliver Motenbruck and Eberhard Gill, Satellite Orbits: Models, Methods and Applications, Springer, 2000.
2. Marcel J. Sidi, Spacecraft Dynamics and Control, Cambridge University Press, 1997.

REFERENCE:

1. Escobal,P.R., Methods of Orbit Determination, John Wiley & Sons, 1965

MA965 FINITE ELEMENT ANALYSIS

L T P C
4 0 0 4

UNIT I 1-D FINITE ELEMENT ANALYSIS 12

Historical Background – Weighted Residual Methods – Basic concept of FEM – Variational formulation of BVP – Ritz Method – Finite Element Modelling – Element Equations – Linear and higher order shape functions – Advantages and disadvantages – Applications to solid mechanics & heat transfer.

UNIT – II ISO-PARAMETRIC FORMULATION 12

Natural & Global coordinate systems – Lagrangian Interpolation polynomials – Isoparametric Elements – Formulation – Numerical Integration – 1D & 2D Triangular elements – Rectangular elements.

UNIT – III 2-D FINITE ELEMENT ANALYSIS 12

Linear and higher order shape functions - Basic BVPs in 2D - Triangular, quadrilateral, higher order elements – Poisson & Laplace Eqn.– Weak formulation – Element matrices and vectors – Applications to Heat transfer, Fluid mechanics, Radial and axisymmetric field problems

UNIT – IV 3-D FINITE ELEMENT ANALYSIS 12

Basic BVPs in 3D – Poisson & Laplace Equation – Weak formulation – Element matrices and vectors

UNIT – V SPECIAL TOPICS 12

Dynamic Analysis – Equations of motion – mass matrices – free vibration analysis – natural frequencies of longitudinal, transverse and torsional vibration – Introduction to transient field problem- Nonlinear analysis

L : 60

BOOK FOR STUDY :

1. Reddy, J.N. – An Introduction to Finite Element Method, 2nd Edition, McGraw Hill, New York,1993.

REFERENCES:

1. Segerlind, L.J. – Applied Finite Element Analysis, John Wiley & Sons, New York, 1984.
2. Rao, S.S. – Finite element Method in Engineering, 3rd Edition, Pergamon Press, Oxford, 1989.
3. Chandrupatla & Belagundu – Introduction to Finite elements in Engineering 2nd Edition, Prentice Hall, 1997.

MA966 SPACE GEOMETRY AND SATELLITE TRACKING

L T P C
4 0 0 4

UNIT – I SPACE MISSION GEOMETRY 12

Introduction to Geometry on the Celestial Sphere – Earth geometry viewed by space – Apparent motion of Satellites from an Observer on the Earth – Satellite Ground tracks – Development of Mapping and Pointing Budgets

UNIT – II ORBIT AND CONSTELLATION DESIGN 12

The orbit Design Process – Earth Coverage – The Delta V Budget – Selecting Orbits for Earth Referenced Spacecraft – Constellation Design.

UNIT – III COORDINATE SYSTEMS AND TRANSFORMATIONS 12

Coordinate system in General – Azimuth and Elevation system – Right Ascension and Declination system – Latitude and Longitude systems – Orbit Plane System – Oblate Spheroidal System – Vehicle-Centered System – Coordinate Transformations

UNIT – IV DETERMINATION OF AN ORBIT FROM ANGLES ONLY 12

The Angles-Only Problem – Transformation of Non-Inertial Observations to Inertial Observations – Method of Gauss – Method of Laplace – The Double r-Iteration – Orbit determination from three sets of angles.

UNIT – V SATELLITE TRACKING AND OBSERVATION MODELS 12

Tracking Systems-Radar Tracking – Laser Tracking – GPS – Tracking Data Models – Transmitter and Receiver Motion – Angle Measurements – Range Measurements – Doppler Measurements- Media Corrections.

L: 60

BOOKS FOR STUDY:

1. Oliver Motenbruck and Eberhard Gill, Satellite Orbits: Models, Methods and Applications, Springer, 2000.
2. Escobal,P.R., Methods of Orbit Determination, John Wiley & Sons, 1965.
3. Wertz,J.R., and Larson,W.J., Space Mission Analysis and Design, Third Edition, Kluwer Academic Publishers, 2000.

REFERENCE:

1. Vladamir.A.Chobotov, Orbital Mechanics , Second edition , American Institute of Aeronautics and Astronautics, June 1996.

MA967 BOUNDARY LAYER FLOWS

L T P C
4 0 0 4

UNIT – I DERIVATION AND PROPERTIES OF NAVIER-STOKE'S EQUATIONS 14

Equations of motion and continuity – Stress system – relation between stress and strain - Stoke's hypothesis – Navire-Stoke's equations – Derivation – Interpretation – Limiting case.

UNIT – II EXACT SOLUTIONS 10

Exact solutions of the Navire-Stoke's equations – Parallel flow – Other exact solutions.

UNIT – III BOUNDARY LAYER EQUATIONS AND THEIR PROPERTIES 12

Derivation of boundary layer equations – Separation – Skin friction – Boundary layer along a flat plate – Similar solutions – Transformation of the boundary layer equations – Momentum and integral equations.

UNIT – IV EXACT AND APPROXIMATE METHODS 12

Exact solutions of boundary layer equations – Flow past a wedge – Approximate methods – Application of the momentum equation – Von Karman and Pohlhausen method – Comparison – Methods of boundary layer control.

UNIT – V TURBULENT BOUNDARY LAYERS 12

Turbulent flow – Introduction – Mean motion and fluctuations – Apparent stresses – Derivation of the stress tensor – Assumptions for turbulent flows – Prandtl's mixing theory.

L : 60

BOOK FOR STUDY:

1. Schlichting, H. Boundary layer theory, Mc Graw Hill, 7th Edition,1979.

REFERENCES:

1. Batchelor,G.K., An Introduction to fluid dynamics, Cambridge University Press, 1979.
2. Yuan,S.W., Foundations of fluid mechanics, Prentice-Hall, 1988.

MA968 GENERALIZED INVERSES

L T P C
4 0 0 4

UNIT I EXISTENCE AND CONSTRUCTION OF GENERALIZED INVERSES 12

The penrose equations – Existence and construction of {1} inverses – Properties of {1} inverses – Range and null space of a matrix – Existence and construction of {1,2}, {1,2,3}, {1,2,4}and {1,2,3,4} inverses – Full rank factorizations – Construction of {2} inverses of prescribed rank, Explicit formula for A^+.

UNIT – II LINEAR SYSTEMS AND CHARACTERIZATION OF GENERALIZED INVERSES 12

Solution of linear systems – Characterization of A{1,3}, A{1,4}, A{2}, A{1,2} and other subsets of A{2} – Idempotent matrices and projectors – Generalized inverses with prescribed range and null space – Orthogonal projections and orthogonal projectors – Characterization of classes of generalized inverses – Restricted generalized inverses – Bott–Duffin inverse – An application of 1–inverses in interval linear programming, A{1,2} inverse for the integral solution of Linear equations – An application of Bott-Duffin inverse to electrical Network.

UNIT – III MINIMAL PROPERTIES OF GENERALIZED INVERSES 12

Least squares solutions of inconsistent linear systems – Solutions of minimum norm – Weighted generalized inverses – Least squares solutions and basic solutions, Minors of the Moore-penrose inverse – Essentially strictly convex norms and the associated projectors and generalized inverses – An external property of the Bott-Duffin inverse with application to electrical Network.

UNIT – IV SPECTRAL GENERALIZED INVERSES 12

Introduction – the matrix index – Spectral inverse of a diagonable matrix – The group inverse – Spectral properties of the group inverse – The Drazin inverse –Spectral properties of the Drazin pseudo matrix – Index 1-nilpotent decomposition of a square matrix – Quasi-commuting inverse – Other spectral generalized inverses.

UNIT – V GENERALIZED INVERSES OF PARTITIONED MATRICES 12

Introduction – Partitioned matrices and linear equations – Intersection of manifolds – Common solutions of linear equations and generalized inverses of partitioned matrices –Generalized inverses of bordered matrices.

L: 60

BOOK FOR STUDY:

1. Ben-Israel.A., and Greville, T.N.E. Generalized Inverses: Theory and Application, 2nd Edition, Springer – Verlag, New York, 2003.

REFERENCES:

1. Nashed,M.Z., Generalized Inverses and Application, Academic Press, 1974.
2. Rao,C.R., and Mitra, S. K., Generalized inverses of Matrices and its Applications, John Wiley, New York, 1971.

MA969 GRAPH THEORY

L T P C
4 0 0 4

UNIT – I FUNDAMENTAL CONCEPTS 12

Graphs as models – Matrices and isomorphism – Paths, Cycles and Traits – Vertex degrees – Eulerian circuits – Hamiltonian cycles – Extremal problems – Graphic sequences – Digraphs.

UNIT – II TREES AND MATCHINGS 12

Properties of trees – Enumeration of trees – Spanning trees in graphs – Shortest path – Maximum matchings – Hall's theorem – Min-max theorems – Independent sets and covers – Dominating sets.

UNIT – III CONNECTIVITY IN GRAPHS 12

Vertex connectivity – Edge connectivity – Blocks – k-connected and k-edge connected graphs – Network flow problems.

UNIT – IV COLORING OF GRAPHS 12

Vertex colorings and upper bounds – Brooks' theorem – Graphs with large chromatic number – Turan's theorem – Counting proper colorings – Chordal graphs.

UNIT – V PLANAR GRAPHS 12

Embeddings and Euler's formula – Dual graphs – Kuratowski's theorem (statement only) – 5 colour theorem – Crossing number.

L : 60

BOOK FOR STUDY:

1. Douglas B. West, Introduction to Graph Theory (2nd Edition), Prentice Hall of India, 2002.

REFERENCES:

1. Murthy U S R and Bondy J A, Graph Theory, Springer, 2008.
2. Harary F, Graph Theory, Narosa Publishing House, 1989.
3. Chartraud,G., Introductory Graph Theory, Dover, 1985.
4. Diestel,R., Graph Theory, 2nd Edition, Springer, 2000.

MA970 ADVANCED GRAPH THEORY

L T P C
4 0 0 4

UNIT – I PERFECT GRAPHS 12

The perfect graph theorem – Chordal graphs – Imperfect graphs – The strong perfect graph conjecture.

UNIT – II RAMSEY THEORY 12

The pigeonhole principle – Ramsey's theorem – Ramsey numbers – Graph Ramsey theory.

UNIT – III MORE EXTREMAL PROBLEMS **12**

Encodings of graphs – Branchings and gossip – List coloring and choosability – Partitions using paths and cycles, circumference.

UNIT – IV RANDOM GRAPHS **12**

Existence and expectation – Properties of almost all graphs – Threshold functions – Evolution and graphs parameters – Connectivity, cliques and coloring – Martingales

UNIT – V EIGENVALUES OF GRAPHS **12**

The characteristic polynomial – Linear algebra of real symmetric matrices – Eigenvalues and graph parameters – Eigenvalues of regular graphs – Strongly regular graphs.

L : 60

BOOK FOR STUDY:

1. Douglas B. West, Introduction to Graph Theory, (2nd Edition), Prentice Hall of India, 2002.

REFERENCES:

1. Murthy U S R and Bondy J A, Graph Theory, Springer, 2008.
2. Biggs,N.,Algebraic Graph Theory, Cambridge Tracts in Mathematics 67, Cambridge University Press, 1974.
3. Bollabas,B., Random Graphs, Academic Press, 1985.
4. Golumbic,M.C., Algorithmic Graph Theory and Perfect Graphs, Academic Press, New York, 1980.
5. Ramsey Theory, Graham,R.L., Rothschild,B.L., Spencer.J.H., (2nd Edition), Wiley Publishers, 1990.

MA971 SPECIAL FUNCTIONS

L T P C
4 0 0 4

UNIT – I SPECIAL FUNCTIONS **12**

Introduction – Beta and Gamma Functions – Euler Reflection Formula – The Hurwitz and Riemann zeta functions – Stirling's Asymptotic Formula – Gauss's Multiplication Formula for $\Gamma(mx)$ – ratio of two gamma functions – Integral Representations for $Log\,\Gamma(x)$ and $\psi(x)$ – Kummer's Fourier Expansion of $Log\,\Gamma(x)$ - The Bohr-Mollerup Theorem – Gauss and Jacobi Sums – A Probabilistic Evaluation of the Beta Function – The p-adic Gamma Function.

UNIT – II HYPERGEOMETRIC FUNCTIONS **12**

Hypergeometric Differential Equations – Gauss Hypergeometric Function – Elementary Properties – Contiguous Relations – Integral Representation – Linear and Quadratic Transformation and Summation Formulae – Analytic Continuation – Barnes' Contour Integral Representation.

UNIT – III GENERALIZED HYPERGEOMETRIC FUNCTIONS **12**

Generalized Hypergeometric Functions – Elementary Properties – Contiguous Relations – Integral Representation – Transformation and Summation Formulae – Whipple's Transformation – The Confluent Hypergeometric Equation – Barne's Integral for ${}_1F_1$ - Whittaker Functions – Examples of ${}_1F_1$ and Whittaker Functions.

UNIT – IV ORTHOGONAL POLYNOMIALS 12

Zeros – Fundamental Recurrence Formula, Systematic Moment Functions – Representation Theorem – Spectral Points and zeros of Orthogonal Polynomials – Chain Sequence and Orthogonal Polynomials – Some Spectral Analysis – Orthogonal Polynomials whose zeros are dense in intervals – Kreine's Theorem.

UNIT – V SPECIFIC ORTHOGONAL POLYNOMIALS 12

Some specific systems of orthogonal polynomials like Hermite – Laguerre – Jacobi, Ultraspherical – Hahn – Meixner – Charlier – Steiltjes – Wegert – q-Polynomials of Al-Salam and Carlitz – Wall Polynomials.

L : 60

BOOKS FOR STUDY:

1. Andrews,G.E., Askey,R., Ranjan Roy, Special Functions, Encyclopedia of Mathematics and its Applications, Cambridge university Press, 1999.
2. Nevai,P.G., Orthogonal Polynomials, Memoirs of AMS, 1981.

REFERENCES:

1. Copson.E.T., Theory of Functions of Complex Variables, Oxford University Press, London, 1935.
2. Rainville E.D., Special Functions, Macmillan, New York, 1960.
3. Chihara,T.S., An Introduction to Orthogonal Polynomials, Gordon and Breach, 1978.
4. Szego,G., Orthogonal Polynomials, Memoirs of AMS, 1939.

MA972 BASIC HYPERGEOMETRIC SERIES

L T P C
4 0 0 4

UNIT – I INTRODUCTION TO Q-SERIES 12

Introduction – A q-Analogue of Differentiation and Integration – Simple q-Differentiation and q-Integration Formulae – The q-Binomial Theorem – q-Exponential Functions – q-Analogue of Circular Functions – q-Gamma and q-Beta Functions.

UNIT – II BASIC HYPERGEOMETRIC SERIES 12

Basic Hypergeometric Series – Heine's Transformation Formulas for ${}_2\phi_1$ series – Heine's q-Analogue of Gauss' Summation Formula – q-Analogue of Saalschiitz's Summation Formula– The Bailey-Daum Summation Formula – Generalized q-Hypergeometric Functions – well-poised, nearly-poised and very-well-poised Basic Hypergeometric Series.

UNIT – III SUMMATION AND TRANSFORMATION FORMULAS 12

A Summation Formula of terminating very-well-poised Series – Watson's Transformation Formula for Terminating very-well-poised Series – Bailey Transformation Formula for Terminating Series – Two-term transformation Formula.

UNIT – IV BILATERAL BASIC HYPERGEOMETRIC SERIES 12

Bilateral Basic Hypergeometric Series – Ramanujan's sum – Bailey's sum of a very-well-poised Series – A General Transformation Formula for an ${}_r\psi_r$ Series – A General Transformation Formula for a very-well-poised Series – Transformation Formulas for very-well-poised Series.

UNIT – V THETA AND ELLIPTIC FUNCTIONS 12

Theta Functions – Elementary Properties – Zeros – Relation among Squares of Theta Functions – Pseudo Addition Theorem – Infinite Products – Elliptic Functions – Differential Equations – The Function *sn*(*u*), *cn*(*u*), *dn*(*u*) – Relation involving Squares – Relation Involving Derivatives – Addition Theorem.

L : 60

BOOKS FOR STUDY:

1. Gasper.G., and Rahman,M. Basic Hypergeometric Series, Encyclopedia of Mathematics and its Applications, Cambridge University Press, New York, 1990.
2. Rainville E.D., Special Functions, Macmillan, New York, 1960.

REFERENCES:

1. Exton, H., Multiple Hypergeometric Functions and Applications, Halsted Press (Ellis Horwood Limited, Chichester), John Wiley and Sons, New York, London, Sydney, and Toronto, 1976.
2. Whittaker, E. T.; Watson, G. N., A Course of Modern Analysis, Fourth Edition, Cambridge University Press, Cambridge, London, and New York, 1927.

MA973 UNIVALENT FUNCTIONS L T P C
4 0 0 4

UNIT – I ELEMENTARY THEORY OF UNIVALENT FUNCTIONS 12

The Area theorem-Growth and Distortion Theorems-Coefficient Estimates-Convex and Starlike functions-Close to Convex functions-Spirallike functions-Typically Real functions**.**

UNIT – II VARIATIONAL METHODS 12

A Primitive Variational Method-Growth of Integral Means-Odd Univalent functions-Asymptotic Bieberbach Conjecture**.**

UNIT – III SUBORDINATION 12

Basic Principles-Coefficient Inequalities-Sharpened Forms of the Schwartz Lemma – Majorization-Univalent Subordinate Functions.

UNIT – IV GENERAL EXTREMAL PROBLEMS 12

Functionals of Linear Spaces-Representation of Linear Functionals-Extreme Points and Support Points- Properties of extremal Functions-Extreme Points of S, Extreme Points of $\sum$.

UNIT –V INTEGRAL TRANSFORMS 12

Alexander Transforms – Libera Transforms – Bernardi Transforms – Hohlov Operator –Carlson and Shaffer Operator – Komatu Operator – Fournier and Ruscheweyh Operator

L : 60

BOOKS FOR STUDY:

1. Peter L. Duren., Univalent Functions, Springer Verlag, May 1983.
2. Goodman,A.W., Univalent Functions, Volume 1 ,11, Polygonal Publishing House, 1983.

REFERENCES :
1. Carlson.B.C., and D.B. Shaffer, Starlike and prestarlike hypergeometric functions, SIAM J.Math,. Anal. 15(4) 1984, 737-745.
2. Hohlov,Y.E., Convolution Operator preserving univalent functions, Pliska Stud. Math. Bulgar. 10, 1989, 87-92.
3. Fournier,R., St.Ruscheweyh,On two extremal problems related to univalent functions, Rocky Mountain.J. Math. 24 , 1994, 529-538.
4. Komatu,Y., On analytic prolongation of a family of operators, Mathematica (Cluj) 258, 2001, 466 – 489.

MA974 FUNDAMENTALS OF CHEMICAL GRAPH THEORY

L T P C
4 0 0 4

UNIT – I THE ORIGINS OF CHEMICAL GRAPH THEORY: 12

The first use of Chemical Graphs – The emergence of Structure Theory – The concept of valence – The growth of Chemical Graph Theory – The introduction to Topological Indices – Elementary Bonding Theory.

UNIT – II ELEMENTS OF GRAPH THEORY FOR CHEMIST 12

Some Graph Theoretical Terms – Connectedness of Graphs – Planarity of Graphs – Operations on Graphs – Matrix Representation of graphs – Distances in Graphs and Digraphs – Metric and Topological Spaces for simple graphs – Graphs in Quantum Chemistry.

UNIT – III POLYNOMIALS IN GRAPH THEORY 12

On Chemical Applications of Graphic Polynomials – Polynomials – The Characteristic Polynomial – Matching Polynomial – More graphic polynomials.

UNIT – IV ENUMERSATIONS OF ISOMERS 12

Introduction – Definitions and Mathematical background – Polya's theorem – Generalized polya theorem – Valence isomers – Polyhexes – Isomers and computer programma for their generations – Isomerism and Reaction Graphs.

UNIT – V GRAPH THEORY AND MOLECULAR ORBITALS 12

Introduction – Elements of Graph Spectral Theory – Huckel Theory – Isomorphism of Huckel Theory and Graph Spectral Theory – Topological Resonance Theory.

L : 60

BOOK FOR STUDY:

1. Bonchev.D. and Rouvary D.H, Chemcial Graph Theory: Introduction and Fundamentals – Abacus Press / Gordon & Breach Science Publishers, New York, 1991.

REFERENCES:

1. Trinajstic.N., Chemical Graph Theory, Volume I and II, CR Press, 2000, Florida.
2. Douglas B. West, Introduction to Graph Theory, Prentice Hall of India, 2002.

MA975 FUNCTIONAL ANALYSIS AND APPLICATIONS TO PDE

L T P C
4 0 0 4

UNIT – I DISTRIBUTION THEORY 12

Distributions, operations with distributions, support and singular support, convolutions, fundamental solutions, Fourier transform, tempered distributions.

UNIT – II SOBOLEV SPACES 12

Basic properties, approximation by smooth functions and consequences, imbedding theorems, Rellich-Kondrasov compactness theorem, fractional order spaces, trace spaces, dual spaces, trace theory.

UNIT – III WEAK SOLUTIONS OF ELLIPTIC EQUATIONS 12

Abstract variational results (Lax-Milgram lemma, Babuska-Brezzi Theorem), existence and uniqueness of weak solutions for elliptic boundary value problems (Dirichlet, Neumann and mixed problems), regularity results.

UNIT – IV METHODS 12

Galerkin method, maximum principles, Eigenvalues problems, introduction to the mathematical theory of the finite element method.

UNIT – V EVOLUTION EQUATIONS 12

Unbounded operators, exponential map, C_o-semigroups, Hille-Yosida theorem, contraction Semigroups in Hilbert spaces, applications to the heat, wave and Schrodinger equations, inhomogeneous problems.

L : 60

BOOK FOR STUDY:

1. S.Kesavan, Topics in Functional Analysis and Applications, Wiley-Eastern (New Age International Ltd.), 1989.

REFERENCE:

1. L.C.Evans, Partial Differential Equations, Graduate Studies in Mathematics 19, AMS, 1998.