UNIVERSITY DEPARTMENTS

ANNA UNIVERSITY:: CHENNAI 600 025

REGULATIONS 2013

M. Phil. (MATHEMATICS)

SEMESTER I

SL. NO.	COURSE NO	COURSE TITLE	L	T	P	C
1	MX8101	Algebra and Analysis	4	0	0	4
2	MX8102	Applied Combinatorics	4	0	0	4
3	MX8103	Nonlinear Dynamics	4	0	0	4
		TOTAL	**12**	**0**	**0**	**12**

SEMESTER II

SL. NO.	COURSE NO	COURSE TITLE	L	T	P	C
		Elective	4	0	0	4
	MX8211	Project	0	0	32	16
		TOTAL	**4**	**0**	**32**	**20**

ELECTIVES

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	MX8001	Advanced Number Theory and Cryptography	4	0	0	4
2.	MX8002	Advances in Graph Theory	4	0	0	4
3.	MX8003	Algebraic Theory of Semigroups	4	0	0	4
4.	MX8004	Basic Hypergeometric Series	4	0	0	4
5.	MX8005	Boundary Layer Flows	4	0	0	4
6.	MX8006	Differential Topology	4	0	0	4
7.	MX8007	Fixed Point Theory and its Applications	4	0	0	4
8.	MX8008	Fundamentals of Chemical Graph Theory	4	0	0	4
9.	MX8009	Generalized Inverses	4	0	0	4
10.	MX8010	Harmonic Analysis	4	0	0	4
11.	MX8011	Heat and Mass Transfer	4	0	0	4
12.	MX8012	Molecular Computing	4	0	0	4
13.	MX8013	Optimization Techniques	4	0	0	4
14.	MX8014	Representation Theory of Finite Groups	4	0	0	4
15.	MX8015	Special Functions	4	0	0	4
16.	MX8016	Univalent Functions	4	0	0	4

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF M.PHIL DEGREE : 32

Attested

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MX8101 **ALGEBRA AND ANALYSIS** **L T P C**
4 0 0 4

OBJECTIVE:

- To introduce the advanced topics in algebra, real and complex analysis.

OUTCOME:

- The students are capable of handling the advanced topics in algebra and analysis.

UNIT I MODULES **12**

Basic Definitions – Quotient Modules – Module Homomorphisms – Generation of Modules – Direct Sums – Free Modules.

UNIT II STRUCTURE OF MODULES **12**

Change of scalars -Simple Modules - Semi-simple Modules - Structure of Semi-simple Modules - Chain conditions – The Radical.

UNIT III ABSTRACT INTEGRATION **12**

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 IV ELEMENTARY PROPERTIES OF HOLOMORPHIC FUNCTIONS **12**

Complex differentiation – Integration over paths – The local Cauchy theorem – The power series representation – The open mapping theorem – The global Cauchy theorem – The calculus of residues.

UNIT V FOURIER TRANSFORMS **12**

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

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Pierce R.S., ”Associative Algebras, Graduate Texts in Mathematics”, Springer Verlag, NewYork, 1982.
2. Rudin W., “Real and Complex Analysis”, Tata Mc-Graw Hill, Third Edition, 2006.

REFERENCES:

1. Serge Lang, “Algebra”, Addisson Wesley, Third Edition, 2005.
2. Paul R. Halmos, “Measure Theory”, Springer 1974.
3. Royden, H.L., “Real Analysis”, The Macmillan Company, New York, Third Edition, 1988.
5. Elras, M. Stein and Ramishakarchi, “Complex Analysis”, Princeton University Press, 2003.

MX8102 **APPLIED COMBINATORICS** **L T P C**
4 0 0 4

OBJECTIVE:

- To introduce advanced database in combinatorial mathematics.

OUTCOME:

- Students will be able to apply combinatorial techniques in design theory, coding theory and ptimization problems.

UNIT I TOOLS OF COMBINATORICS 12

Generating permutations and combinations – Exponential generating function and generating function for permutations – Recurrence relation – Solving recurrence relation using generating function – Principle of inclusion and exclusion and its applications.

UNIT II POLYA THEORY OF COUNTING 12

Burnside's Lemma – Distinct colorings – Cycle index – Polya's theorem.

UNIT III COMBINATORIAL DESIGNS 12

Balanced incomplete block designs – Necessary condition for existence of (b, v, r, k, λ) designs. Resolvable designs – Steiner triple systems – Symmetric balanced incomplete block designs – Projective plans, Latin squares and (v, k, λ) designs.

UNIT IV CODING THEORY 12

Encoding and decoding – Error correcting codes – Linear codes – Use of block designs to find error correcting codes.

UNIT V COMBINATORIAL OPTIMIZATION 12

Matching – Bipartite matching – System of distinct representatives – Algorithm for finding maximum matching – Networks – Maximum flow problem – The max flow algorithm – Complexity of max flow algorithm.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Fred S. Roberts and Barry Tesman, "Applied combinatorics", CRC Press, Second Edition, 2009.

REFERENCES:

1. Peter J. Cameron," Combinatorics: Topics, Techniques, Algorithms", CambridgeUniversity Press, First Edition, 1995.
2. Alan Tucker, "Applied Combinatorics", Wiley, Sixth Edition, 2012.
3. Richard A. Brualdi, "Introductory Combinatorics", Pearson Education, Fifth Edition, 2011.
4. Daniel I. A. Cohen ,"Basic Techniques of Combinatorial Theory", John Wiley & Sons,1979.

MX8103 **NONLINEAR DYNAMICS** **L T P C**
4 0 0 4

OBJECTIVE:

- This subject introduces the students to the full range of current and background activity in the rapidly growing field of non-linear dynamics.

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OUTCOME:

- Emphasises a step-by-step introduction to dynamics and geometry in state space to help in understanding non linear dynamics and a thorough treatment of both differential equation models and iterated map models.

UNIT I DYNAMICS OF DIFFERETIAL EQUATIONS 12

Integration of linear second order equations – Integration of nonlinear second order equations – Dynamics in the phase plane – Linear stability analysis – Non autonomous systems.

UNIT II HAMILTONIAN DYNAMICS 12

Lagrangian formulation of Mechanics – Hamiltonian formulation of Mechanics – Canonical transformations – Hamilton-Jacobi equation and action – Angle variables integrable Hamiltonians.

UNIT III CLASSICAL PERTURBATION THEORY 12

Elementary perturbation theory – Canonical perturbation theory – Many degrees of freedom and the problem of small divisors – The Kolmogrov – Arnold-Moser theorem.

UNIT IV NONLINEAR EVOLUTION EQUATIONS AND SOLUTIONS 12

Basic properties of the Kdv equation – The inverse Scattering transforms: Basic principles, Kdv equation – Other solution systems – Hamiltonian structure of integrable systems.

UNIT V ANALYTIC STRUCTURE OF DYNAMICAL SYSTEMS 12

Ordinary differential equations in the complex domain – Integrable systems of ordinary differential equations – Painleve property of partial differential equations**.**

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Tabor M., “Chaos and Integrability in Nonlinear Dynamics”, John Wiley and Sons, New York, 1989.

REFERENCES:

1. Lakshmanan M. and Rajasekar S., “Nonlinear Dynamics”, Springer-Verlag, New York, First Edition, 2002.
2. Strogatz S.H., “Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry and Engineering (Studies in Nonlinearity), Westview Press, USA, First Edition, 2001.

MX8001 ADVANCED NUMBER THEORY AND CRYPTOGRAPHY L T P C
4 0 0 4

OBJECTIVE:

- To introduce the fundamentals of Number Theory and Cryptography such as congruences, residues and partitions.

OUTCOME:

- Students should be able to understand and apply the concepts in solving problems of cryptosystems.

UNIT I CONGRUENCES 12

Congruences, Solutions of congruences, congruences of deg 1, The function 0 (n) - Congruences of higher degree, Prime power moduli, Prime modulus, congruences of degree 2, Prime modulus, Power residues.

UNIT II QUADRATIC RESIDUES 12

Quadratic residues, Quadratic reciprocity, The Jacobi symbol, greatest integer function, arithmetic function, The Mobius Inversion formula, The multiplication of arithmetic functions.

UNIT III DIOPHANTINE EQUATIONS 12

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 IV TRADITION SYMMETRIC – KEY CIPHERS 12

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

UNIT V ASYMMETRIC KEY CRYPTOGRAPHY 12

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

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Ivan Niven, Herbert S.Zuckermann, Hugh L. Montgomery, “An Introduction to The Theory of Numbers”, John Wiley, Fifth Edition, 2006.
2. Behrouz A. Forouzan, “Cryptography & Network Security”, Tata McGraw Hill, Special Indian Edition, 2007.

REFERENCES:

1. Tom M. Apostol, “Introduction to analytic number theory”, Narosa Publishing House, 1980.
2. Rose H.E., “A Course in Number Theory”, Clarendon Press, Second Edition, 1995.
3. Kenneth Ireland & Michael Rosen, “A Classical Introduction to Modern Number Theory”, Springer International Edition, Second Edition, 2010**.**
4. Koblitz, N., “A course in number theory and Cryptography”, Springer Verlag,1994.
5. Stinson D.R., “Cryptography: Theory and Practice”, CRC Press, Third Edition, 2002.

MX8002 ADVANCES IN GRAPH THEORY L T P C
4 0 0 4

OBJECTIVE:

- To introduce advanced topics in Graph Theory.

OUTCOME:

- Students will be able to pursue research in frontier areas of Graph Theory.

UNIT I CONNECTIVITY IN GRAPHS 12

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

UNIT II COLORING OF GRAPHS 12

Vertex colorings and upper bounds – Brooks' theorem – Graphs with large chromatic number – Turan's theorem – Counting proper colorings – Edge colouring – Characterization of line graphs.

UNIT III PLANAR GRAPHS 12

Embeddings and Euler's formula – Dual graphs – Kuratowski's theorem – 5 colour theorem – Crossing number – Surface of higher genus.

UNIT IV RAMSEY THEORY 12

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

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.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Douglas B. West, "Introduction to Graph Theory", Prentice Hall of India, Second Edition, 2002.

REFERENCES:

1. Bondy J. A, and Murty U. S. R., "Graph Theory", Springer, 2008.
2. Balakrishnan R. and Ranganathan K., " A textbook of Graph Theory", Springer, 2012.
3. Graham R.L., Rothschild B.L and Spencer J.H., "Ramsey Theory", Wiley Publishers, Second Edition, 1990.
4. Biggs N., "Algebraic Graph Theory", Cambridge Tracts in Mathematics 67, Cambridge University Press, 1994.

MX8003 ALGEBRAIC THEORY OF SEMIGROUPS L T P C
4 0 0 4

OBJECTIVE:

- To introduce the branch of Algebraic concepts developed on Semigroups.

OUTCOME:

- The students have learnt the treatment on the theory of Semigroups.

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 III 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.

TOTAL: 60 PERIODS

TEXT BOOKS:

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", Cambridge University Press, Cambridge, 2006.

MX8004 BASIC HYPERGEOMETRIC SERIES **L T P C**
4 0 0 4

OBJECTIVE:

- To introduce an extension of Beta, Gamma functions, Hypergeometric series, bilateral series developed on q-analogue and its application on theta and elliptic functions.

OUTCOME:

- The students have learnt the q-analogue along with an extension of Concepts of Beta, Gamma function and its application on elliptic and theta functions.

UNIT I INTRODUCTION TO Q-SERIES **12**

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 Formula – 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 – Transformation Formula for an generalized bilateral 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*) – Addition Theorem.

TOTAL: 60 PERIODS

TEXT BOOKS:

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., and Watson G. N., "A Course of Modern Analysis", Cambridge University Press, Cambridge, London and New York, Reprint 1996.

MX8005 BOUNDARY LAYER FLOWS L T P C
4 0 0 4

OBJECTIVE:

- To give a comprehensive overview of boundary layer theory and its application to all areas of fluid mechanics with emphasis on the flow past bodies.

OUTCOME:

- To familiarize the student with laminar transitional, boundary layers and free sheer flows.

UNIT I DERIVATION AND PROPERTIES OF NAVIER-STOKE'S EQUATIONS 12

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

UNIT II EXACT SOLUTIONS 12

Hagen – Poiseuille theory – Flow between two concentric rotating cylinders – Couette Motion – 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 – Characteristics of a boundary layer - 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 - Flow past a cylinder – Approximate methods – Application of the momentum equation – Von Karman and Pohlhausen method – Comparison – Methods of boundary layer control.

UNIT V TURBULENT BOUNDARY LAYERS 12

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

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Schlichting H., "Boundary layer theory", Tata Mc Graw Hill, Seventh Edition,1979.

REFERENCES:

1. Batchelor G.K., "An Introduction to fluid dynamics", Cambridge University Press, Second Edition, 2000.
2. Yuan S.W., "Foundations of fluid mechanics", Prentice-Hall, 1988.

MX8006 DIFFERENTIAL TOPOLOGY L T P C
4 0 0 4

OBJECTIVE:

- To introduce the notion of smooth manifolds and classify compact one manifolds and smooth compact surfaces.

OUTCOME:

- Differential manifolds occur in different fields like mathematics, physics, mechanics and economics. A course in differential topology will equip the students with techniques and results required to solve problems involving manifolds.

UNIT I MANIFOLDS AND MAPS 12

Derivatives and tangents-inverse function theorem and immersions-submersions -homotopy and stability-Sard's theorem and Morse functions-embedding manifolds in Euclidean space.

UNIT II TRANSVERSALITY AND INTERSECTION 12

Manifolds with boundary- one manifolds and some consequences – transversality -intersection theory modulo 2-winding numbers and the Jordan – Brouwer separation theorem.

UNIT III ORIENTED INTERSECTION THEORY 12

Orientation on manifolds – oriented intersection number-degrees of maps- fundamental theorem of algebra -Euler characteristic as an intersection number.

UNIT IV APPLICATIONS OF INTERSECTION THEORY 12

Lefschetz Fixed point theory – Borsuk Ulam theorem – vector fields-isotopy-Hopf degree theorem.

UNIT V COMPACT SMOOTH SURFACES 12

Morse functions, Morse Lemma, Connected sum, attaching handles, Handle decomposition theorem, Application to smooth classification of compact smooth surfaces.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Guillemin V. and Pollack A., "Differential Topology" , Prentice-Hall, 1974.
2. Morris W. Hirsch, "Differential topology", Springer-Verlag, 1976.

REFERENCES:

1. Milnor J., “Topology from the differentiable viewpoint, Princeton Landmarks in Mathematics”, Princeton University Press, 1997.
2. Shastri A.R., “Elements of Differential Topology”, CRC Press, 2011.

MX8007 FIXED POINT THEORY AND ITS APPLICATIONS L T P C
4 0 0 4

OBJECTIVE:

- To identify all self-maps in which at least one element is left invariant.

OUTCOME:

- The student will be able to apply fixed point theory in various branches of applied mathematics.

UNIT I THE BANACH FIXED POINT THEOREM AND ITERATIVE METHODS 12

The Banach fixed point theorem – The significance of Banach fixed point theorem – Applications to nonlinear equations – The Picard – Lindelof theorem – The Main theorem for iterative methods for linear operator equation – Applications to systems of linear equations and to linear integral equations.

UNIT II THE SCHAUDER FIXED POINT THEOREM AND COMPACTNESS 12

Extension theorem – Retracts – The Brouwer fixed point theorem – Existence principle for systems of equations – Compact operators – Schauder fixed – point theorem – Peano’s theorem – Systems of Integral equations and semi linear differential equations.

UNIT III FIXED POINTS OF MULTIVALUED MAPS 12

Generalized Banach fixed point theorem – Upper and lower semi continuity of multi-valued maps – Generalized Schauder fixed point theorem – Variational inequalities and Browder fixed point theorem.

UNIT IV NONEXPANSIVE OPERATORS AND ITERATIVE METHODS 12

Uniformly convex Banach spaces – Demiclosed operators – The fixed point theorem of Browder, Gohde and Kirk – Demicompact operators – Convergence principles in Banach spaces – Modified successive approximations – Applications to periodic solutions.

UNIT V CONDENSING MAPS 12

A noncompactness measure – Condensing maps – Operators with closed range and an approximation technique for constructing fixed points – Sadovskii’s fixed point theorem for condensing maps – Fixed point theorem for perturbed operators – Application to differential equations in Banach spaces.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Zeidler E., ”Nonlinear Functional Analysis and its applications”, Vol. 1, Springer-Verlag, New York, 1989.

REFERENCES:

1. Mohamed A. Khamsi & William A. Kirk, “An Introduction to Metric Spaces and Fixed Point Theory”, John Wiley & Sons, New York, 2001.
2. Deimling K., “Nonlinear Functional Analysis”, Springer-Verlag, New York, 1985.
3. Smart D.R., “Fixed Point Theory”, Cambridge University Press, 1980.

4. Istratescu V.L., “Fixed Point Theory: An Introduction”, D. Reidel Publishing Company, Boston, 1979.
5. Mohan C. Joshi, Ramendra K. Bose,” Some Topics in Nonlinear Functional Analysis”, John Wiley & Sons Australia, Limited, 1985.

MX8008 FUNDAMENTALS OF CHEMICAL GRAPH THEORY L T P C
4 0 0 4

OBJECTIVE:

- To study the connection between Chemistry and Graph Theory.

OUTCOME:

- On successful completion of the course, students should be able to apply Graph Theory in chemical problems.

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 ENUMERATIONS OF ISOMERS 12

Introduction – Definitions and Mathematical background – Polya’s theorem – Generalized polya theorem – Valence isomers – Polyhexes – Isomers and computer programme 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.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Bonchev D. and Rouvray D.H, “Chemical Graph Theory: Introduction and Fundamentals “, Abacus Press / Gordon & Breach Science Publishers, New York, 1991.

REFERENCES:

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

MX8009 **GENERALIZED INVERSES** **L T P C**
4 0 0 4

OBJECTIVES:

- To acquaint the students with various techniques of generalized inverses related with optimal and spectral theory.
- To develop generalized inverses of partitioned matrices.

OUTCOME:

- The students are expected to have good knowledge of generalized inverses which will be helpful for research in this field.

UNIT I EXISTENCE AND CONSTRUCTION OF GENERALIZED INVERSES 12

The Penrose equations – Existence and construction of generalized inverses – Properties - Full rank factorizations – Explicit formula for Moore – Penrose inverse of a matrix.

UNIT II LINEAR SYSTEMS AND CHARACTERIZATION OF GENERALIZED INVERSES 12

Solution of linear systems – Characterization of classes of generalized inverses - Generalized inverses and orthogonal projectors – Application of Generalized inverses in Interval Linear Programming.

UNIT III MINIMAL PROPERTIES OF GENERALIZED INVERSES 12

Least - squares solutions of inconsistent linear systems – Solutions of minimum norm –Extremal property of the Bott-Duffin inverse with application to electrical Network.

UNIT IV SPECTRAL GENERALIZED INVERSES 12

Introduction – The group inverse – Spectral properties of the group inverse – The Drazin inverse – Spectral properties of the Drazin - Inverse – Other spectral generalized inverses.

UNIT V GENERALIZED INVERSES OF PARTITIONED MATRICES 12

Introduction – Partitioned matrices and linear equations – Generalized inverses of partitioned matrices and bordered matrices.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Ben-Israel A., and Greville T.N.E., “Generalized Inverses: Theory and Applications”, Springer – Verlag, New York, Second Edition, 2003.

REFERENCES:

1. Nashed M.Z., “Generalized Inverses and Applications”, Academic Press, 1976.
2. Rao C.R. and Mitra S. K., “Generalized inverses of Matrices and its Applications”, John Wiley, New York, 1971.

MX8010 **HARMONIC ANALYSIS** **L T P C**
4 0 0 4

OBJECTIVE:

- The aim of the course is to make the students to understand the basic concepts of Harmonic Analysis.

OUTCOMES:

- The students will have good understanding of Fourier series and intricacies of convergence.
- The student will be able to understand the intricacies of Wiener Tauberian Theorem and invariant subspace problem.

UNIT I FOURIER SERIES 12

Basic properties of topological groups, subgroups, quotient groups and connected groups. Discussion of Haar Measure without proof on R, T, Z, and some simple matrix groups. L^1 (G) and convolution with special emphasis on $L^1(R)$, $L^1(T)$, $L^1(Z)$. Approximate identities. Fourier series. Fejer's theorem.

UNIT II FOURIER INTEGRALS 12

The classical kernels. Fejer's Poisson's and Dirichlet's summability in norm and point wise summability. Fatou's theorem. The inequalities of Hausdorff and Young. Examples of conjugate function series. The Fourier transform. Kernels on R. The Plancherel theorem on R. Plancherel measure on R, T, Z. Maximal ideal space of $L^1(R)$, $L^1(T)$, $L^1(Z)$.

UNIT III HARDY SPACES 12

Hardy spaces on the unit circle, Invariant subspaces. Factoring. Proof of the F. and M. Riesz theorem. Theorems of Beurings and Szego in multiplication operator form. Structure of inner and outer functions. The inequalities of Hardy and Hilbert.

UNIT IV MAXIMAL FUNCTIONS 12

Conjugate functions. Theorems of Kolmogorov & Zygmund and M. Rieze & Zygmund on conjugate functions. The conjugate function as a singular integral. Statement of the Burkholder-Gundy Silverstein Theorem on T. Maximal functions of Hardy and Littlewood translation.

UNIT V WIENER TAUBERIAN THEOREM 9

The Theorems of Wiener and Beurling. The Titchmarsh Convolution Theorem. Wiener's Tauberian theorem. Spectral sets of bounded functions.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Henry Helson, "Harmonic Analysis", Addison-Wesley, 1983.

REFERENCES:

1. Hewitt E. and Ross K.A., "Abstract Harmonic Analysis", Springer-Verlag, Vol. 1, Fourth Edition, 1993.
2. Yitzhak Katznelson., "An introduction to Harmonic Analysis", Cambridge University Press, 2004.
3. Paul Koosis, "Introduction of H_p spaces", Cambridge University Press, Second Edition,1999.
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MX8011 HEAT AND MASS TRANSFER L T P C
4 0 0 4

OBJECTIVE:

- To enable the students to understand the concept of heat and mass transfer and its applications.

OUTCOME :

- The students are capable of solving various complex problems using FEM.

UNIT I HEAT CONDUCTION 12

Concept of Heat conduction – Fundamental law of heat conduction - Steady state heat conduction – Unsteady heat conduction – Numerical solutions of heat 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.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Eckert E.R.G., and Drake R.M., "Heat and mass transfer", Tata McGraw Hill Publishing Co., Second Edition, 1979.

REFERENCES:

1. Gebhart B., "Heat transfer ", McGraw Hill Publishing Co., New York , Second Edition, 1971.
2. Schlichting H., "Boundary Layer Theory", McGraw Hill Publishing Co., Second Edition, 1979.
3. Cengel Y.A., "Heat Transfer", Mc Graw Hill, Second Edition, 2003.

MX8012 MOLECULAR COMPUTING L T P C
4 0 0 4

OBJECTIVE:

- To introduce molecular computing and its recent applications.

OUTCOME:

- Students should be able to understand and apply molecular computing to problems in Mathematics and Theoretical Computer Science.

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.

TOTAL: 60 PERIODS

TEXT BOOKS:

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

REFERENCE:

1. Adleman L.M., Rothemund PWK, 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.

MX8013 OPTIMIZATION TECHNIQUES L T P C
4 0 0 4

OBJECTIVE:

- To introduce various operations research tools in decision making in an organization.

OUTCOME:

- Students will be capable of using advanced techniques in various OR/OM tools in decision making and able to formulate organization problems into OR models for seeking optimal solutions.

UNIT I ADVANCED LINEAR PROGRAMMING AND GOAL PROGRAMMING 12

Dantzig – Wolfe decomposition algorithm – Karmarkar interior – point algorithm – Goal programming algorithms.

UNIT II HEURISTIC PROGRAMMING 12

Greedy Heuristics: Discrete variable heuristic - Continuous variable heuristic – Metaheuristic: Tabu search algorithm - Simulated annealing algorithm - Genetic algorithm.

UNIT III NON-LINEAR PROGRAMMING 12

Unconstrained algorithms: Direct search method - Gradiant method – Constrained algorithms: Separable programming, Chance – constrained programming.

UNIT IV INVENTORY MODELS 12

Static economic – order quantity models: Classical EOQ model – EOQ with price breaks –Dynamic EOQ models: No set up EOQ Model – Set up EOQ model - Continuous review models: Probabilitized EOQ model, Probabilistic EOQ model – Single - period models: No-Setup model, setup model (s-S policy).

UNIT V SIMULATION 12

Nature and need for simulation-Monte-Carlo simulation – Generation of pseudo random numbers by mid-square method, Congruence multiplier method – Test for randomness – Generating random variates for Uniform, Exponential, Erlangian, Poisson, Normal distributions - Applications to simple problems in operations research.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Hamdy A.Taha, "Operations Research-An Introduction", Pearson Education, New Delhi, Ninth Edition, 2012.
2. Geoffrey Gordon, "System Simulation", Prentice Hall of India Pvt. Ltd., New Delhi, Second Edition, 1978.

REFERENCES:

1. Harvey M. Wagner, "Principles of Operations Research with Applications to Managerial Decisions", Prentice-Hall of India Pvt. Ltd., New Delhi, Second Edition, 1975.
2. Rao S.S., "Engineering Optimization: Theory and Practice", Wiley and New Age International, Fourth Edition, 2009.
3. Mokhtar S. Bazara, Hanif D. Sherali and Shetty C.M., "Non-linear Programming-Theory and Algorithms", John Wiley & Sons Inc Singapore, Second Edition, 1993.

MX8014 REPRESENTATION THEORY OF FINITE GROUPS L T P C
4 0 0 4

OBJECTIVE:

- To introduce the concepts the representation theory of Finite Groups and its Applications.

OUTCOME:

- Students will gain in-depth knowledge in Representation theory of Finite groups to pursue research.

UNIT I GROUP REPRESENTATIONS 12

Fundamental concepts – Matrix representations – G-Modules and Group algebra.

UNIT III REDUCIBILITY AND G-HOMOMORPHISMS 12

Reducibility – Complete reducibility and Maschke's theorem – G-homomorphisms and Schur's lemma – Commutant and Endomorphism algebras.

UNIT III CHARACTERS AND TENSOR PRODUCTS 12

Group characters – Inner product of characters – decomposition of group algebra – tensor products – restricted and induced representations.

UNIT IV REPRESENTATION OF SYMMETRIC GROUPS 12

Young subgroups, tableaux and tabloids – dominance and lexicographic ordering – specht modules – branching rule – Kostka numbers.

UNIT V APPLICATIONS IN COMBINATORICS 12

The Robinson-Schensted algorithm – column insertion – increasing and decreasing subsequences – Knuth relations - the hook formula – the determinant formula.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Bruce E. Sagan., "The symmetric group. Representations, combinatorial algorithms, and symmetric functions", The Wadsworth & Brooks/Cole Mathematics Series. Wadsworth & Brooks/Cole Advanced Books & Software, Pacific Grove, CA, 1991.

REFERENCES:

1. William Fulton, "Young tableaux, With applications to representation theory and geometry", London Mathematical Society Student Texts, 35, Cambridge University Press, Cambridge, 1997.
2. C.W. Curtis and I.Reiner., "Representation theory of finite groups and associative algebras", AMS Chelsea Publishing, Providence, RI, 2006.
3. G. James and A. Kerber., "The Representation theory of the symmetric group", Encyclopedia of Mathematics and its Applications, 16. Addison-Wesley Publishing Co., Reading, Mass., 1981.

MX8015 SPECIAL FUNCTIONS L T P C
4 0 0 4

OBJECTIVE:

- To give an expertise treatment in various special function and orthogonal polynomial.

OUTCOME:

- Students are exposed to various special functions and orthogonal polynomials.

UNIT I SPECIAL FUNCTIONS 12

Beta and Gamma Functions – Euler Reflection Formula – The Hurwitz and Riemann zeta functions – Stirling's Asymptotic Formula – Gauss's Multiplication Formula – Ratio of two gamma functions – Integral Representations for Logarithm of Gamma function - The Bohr-Mollerup Theorem

UNIT II HYPERGEOMETRIC FUNCTIONS 12

Hypergeometric Differential Equations – Gauss Hypergeometric Function – Elementary Properties – Contiguous Relations – Integral Representation – Linear and Quadratic Transformation and Summation Formulae.

UNIT III GENERALIZED HYPERGEOMETRIC FUNCTIONS 12

Generalized Hypergeometric Functions – Elementary Properties – Contiguous Relations – Integral Representation – Transformation and Summation Formulae – Whipple's Transformation.

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 – q-Polynomials of Al-Salam and Carlitz – Wall Polynomials.

TOTAL: 60 PERIODS

TEXT BOOKS:

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.

MX8016 UNIVALENT FUNCTIONS L T P C
4 0 0 4

OBJECTIVE:

- To introduce theory and advanced techniques in Univalent functions (advanced Complex Analysis).

OUTCOME:

- Students will gain in-depth knowledge in Univalent functions theory to pursue research.

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.

UNIT V INTEGRAL TRANSFORMS 12

Linear Operators – Nonlinear operators – Conclusion operators - Alexander Transforms – Libera Transforms – Bernardi Transforms.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Goodman, A.W., "Univalent Functions", Volumes I and II, Polygonal Publishing House,1983.

REFERENCES:

1. Peter L. Duren., "Univalent Functions", Springer Verlag, 2001**.**
2. Sanford S. Miller, Petru T. Mocanu," Differential Subordinations: Theory and Applications", Marcel Dekker, 2000.