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Department of Mathematics

Syllabi of Papers offered at M. Sc. Part II (Mathematics) w. e. f. 2010.

Paper 501 Operator theory

L	P	T	Total
4	0	0	4

Spectral theory of linear operators in Normed spaces:.

Spectral theory in finite dimensional normed spaces, Eigen values, Eigen vectors, Eigen spaces, Spectrum and resolvant set of matrix-definitions, Eigen values of an operator, Definition of Regular value, Point, Continuous and Residual spectrum, Spectral properties of bounded linear operators, Properties of Resolvant and Spectrum, Holomorphy and Local holomorphy, Use of complex analysis in spectral theory.

Compact Linear Operators on Normed Spaces and their Spectrum:

Compact linear operators on normed spaces and their properties, Spectral properties of compact linear operators on normed spaces.

Spectral Theory of Bounded Self Adioint Linear Operators:

Spectral properties of bounded self-adjoint linear operator, Theorem on eigenvalues and eigenvectors, Theorems on resolvent set and spectrum, Residual spectrum theorem, Positive operators, Product of positive operators, Projection operators and their properties.

Unbounded Linear operators on Hilbert Space:

Unbounded linear operators and their Hilbert adjoint operators, Symmetric and self-adjoint linear operators, Closed linear operators Closure of Hilbert adjoint, Spectral properties of Hilbert adjoint, Spectral representation of unitary operators and self-adjoint operators, Multiplication and Differential operators, Riesz' s theorem, Sequilinear form and Riesz's representation theorem, Hilbert adjoint operator and its properties, Self-adjoint, Unitary and Normal operators.

References:

[1] Introductory Functional Analysis with applications by Erwin Kreyszig (2ed) John Wiley and Sons., 1978.
[2] Functional Analysis by B. V. Limaye. (2ed). New-Age Int. Pvt. Ltd.
[3] Introduction to Topology and Modern Analysis by G. F. Simmons. Me Graw Hill Book Co.
[4] Functional Analysis by Koftman and Patrie.
[5] Functional Analysis by Sudarshan Nanda. Wiley Eastern.

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Paper 502 Abstract Algebra

L	P	T	Total
4	0	0	4

Groups:
Normal Series, Solvable groups, Nilpotent groups, Direct Products, Finitely generated abelian Groups, Invariants of finite Abelian Group, Sylow theorems, Groups of order p^2,pq

Modules and Rings:
Definitions and Examples, Submodules and Direct sums, R-homomorphism and quotient modules, Completely reducible modules, Free modules, Representation of Linear mappings, Rank of a Linear mapping, Notherian and Artinian Modules, $Hom_R(\oplus M_i, \oplus M_i)$, Weddenburn-Artin theorem, Uniform Modules, Primary Modules, Noether Lasker Theorem

Field:
Irreducible Polynomials and Einstein Criterion, Adjuction of Roots, Algebric Extension, Algebrically closed Field, Splitting fields, Normal Extention, Multiple roots, Finite Fields, Separable Extention.

Galois Theory:
Automorphism groups and fixed fields, Fundamental theorem of Galois theory, Fundamental theorem of algebra, Roots of unity and cyclotomic polynomials, Cyclic extensions, Polynomials solvable by radicals, Symmetric functions, Ruler and compass constructions

References:

[1] P. B._Bhattacharya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra (2nd Edition) Cambridge University Press, Indian Edition, 1997.
[2] I. N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
[3] M. Artin, Algebra, Prentice-Hall of India, 199.1.
[4] P. M. Cohn, Algebra, Vols. I, II & III, John Wiley & Sons, 1982, 1989, 1991.
[5] N. Jacobson, Basic Algebra, Vols. I & II, W. H. Freeman, 1980 (also published by Hindustan Publishing Company).

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Paper 503 Advanced Linear Algebra

L	P	T	Total
4	0	0	4

Linear Operators:

Definition, Null space and Range, Rank-Nullity theorem, Operator inverse, Applicaion to matrix theory, Computation of range and null spaces of a matrix, Matrix of an operator, Operator algebra, Change of basis, Similar matrices and applications.

Inner Product Spaces:

Definitions and examples, Norms, Orthogonal sets, Fourier coefficients and Parseval's identity, Gram-Schmidt process and QR factorization, Approximation and orthogonal projection. Applications of projection theory and orthogonal complements.

Diagonalizable Linear Operator:

Definition of Eigenvalues and Eigenvectors, Spectrum and eigen spaces of an operator, Properties of characteristic polynomial, Geometric and algebraic multiplicities, Linear operator with an eigen basis, Functions of diagonalizable operators, First order matrix differential equations, Estimates of eigen values: Gershgorin's Theorems.

Normal Operators:

Adjoints and classification of operators, The spectral theorem, Application to matrix theory, Extremum principles for Hermitian operators, The power method for dominant eigen values and eigen vectors with secondary approximation, Inverse power method and subspace methods.

References:

[1] Linear Algebra with Applications by J. T. Scheick. McGraw Hill, International Edition, 1997.

[2] Matrix Algebra by S. Biswas. New age Pub. 2nd ed. 1997.

[3] Linear Algebra by A. R. Rao & P. Bhima Shankaram. Tata McGraw Hill Pub. Co. Ltd. New Delhi. 1996.

[4] Principles and Techniques of Applied Mathematics by B. Friendman. Dover, 1990, NY.

[5] Theory of Matrices with Applications by P. Lancaster & M. Tismenetsky. Academic Press, 1985, 2nd ed. NY.

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Paper 5003 Operation Research

L	P	T	Total
4	4	0	8

Inventory Control: . Introduction to various types of inventory problems, Method with known demand function, Economic order quantity (EOQ),Deterministic inventory problems when shortages are allowed and not allowed, EOQ problems with price breaks, Multiitem deterministic inventory problems, Inventory with uncertain demand,Inventory models with stochastic demand.

Queuing Theory: Definition and characteristic of a queuing system, Poisson process and exponential distribution, Classification of queues, Detailed study of M!MII and MfMIc queuing models,

Sequencing Problems: Problems of sequencing, Problems with n-jobs and 2-machines, Problems with n-jobs and 3-machines, Problems with 2-jobs and n-machines.

Theory of Replacement: Introduction, Replacement of equipment that deteriorate gradually, Replacement of equipment that fails completely,Other replacement problems.

PERT - CPM : Introduction to network with basic components, Rules of network construction, Time calculation in network, CPM, PERT, PERT calculations, Advantages of PERT-CPM, Projectcost, Time-cost, Optimization algorithm, Resource allocation and scheduling.

Transportation Problem: Definition of transportation problem, Basic feasible solution (BFS) to transportation problem, Different methods for finding BFS to the transportation problem,Method of finding optimum solution to the transportation problem,Degeneracy for transportation problem.Unbalanced transportation problem.

Assignment Problem: Definition of assignment problem, Unbalanced assignment problem.

Reference:

[1] Operations research by Kanti Swarup, P.K.Gupta and Nan Mohan. S.Chand & Sons, NewDelhi. 7th ed.1994.

[2] Linear Programming by G.Hadley. Oxford & IBH Pub. Co. 1969.

[3] Linear and Non-linear Programming by K.G.Murthy.

[4] Operations Research by S.D. Sharma. Kedarnath Ramnath Pub.1998. Merrut.

[5] Optimization: Theory and Application by S.S.Rao. Wiley Eastern Ltd. 1979, New Delhi.

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Paper 5004 Advanced Operation Research

L	P	T	Total
4	4	0	8

Linear Programming:

General Linear Programming problem (LPP). Canonical and standard from of LPP, Simplex method, Fundamental properties of the solutions, Degeneracy in LPP, Solution of equations using simplex method. Concept of duality, Fundamental theorems of duality, Properties of duality, Revised simplex method..

Integer Pogramming:

Introduction, All and mixed integer programming problems (IPP), Gomory's all-IPP method, All-IPP algorithm. The branch and bound techniques. Zero - One programming.

Post-optimality Analysis

Sensitivity analysis, Discrete change in the cost-vector, in requirement-vector and in the coefficient matrix. Structural changes in LPP.

Dynamic Programming:

Introduction, Recursive equation approach. Characteristic of dynamic programming. Solution of discrete dynamic programming problem, Solution of LPP by dynamic programming, Some application of dynamic programming.

Non- linear Programming :

General non-linear programming problem. Problems of constrained maxima and minima, Lagranges' multipliers, Graphical solutions, kuhn - Tucker conditions, Quadratic programming, Wolfe's modified simplex method, Beale's method.

Non-Linear Programming I-Dim. Minization Methods:

Introduction, Unimodal function, Elimination method, Unrestricted search, Exhaustive search, dichotomous search, Fibonacci method and Golden section method, Interpolation method:- Quadratic and cubic interpolation method, Direct root method.

Constrained and Unconstrained Optimization:

Characteristic of a constrained problem, Direct methods, Cutting plane and feasible directions method, Transportation techniques, Basic penalty function method, Interior and Exterior penalty function methods, Other penalty function methods.

Reference:

1. Operations research by Kanti Swarup. P.K.Gupta and Nan Mohan. S. Chand & Sons, New Delhi, 7th ed. 1994. .
2. Operations Research by S.D.Sharma. Kedamath Ramnath Pub. 1998. Meerut.
3. Optimization: Theory and Applications by S.S.Rao. Wiley Eastern Ltd. 1979, New Delhi.
4. Applied Non-linear Programming by Himmelblan D.M.McGraw Hill Book Co. 1972.
5. Non-linear Programming by B.Martos. North - Holland Pub. Co. Amsterdam.

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Paper 5005 Integral Transform

L	P	T	Total
4	0	0	4

Laplace Transforms:

Introduction and definition of Laplace transforms with examples, Existence condition and basic properties of Laplace transforms, The convolution theorem and properties of convolution, Differentiation and integration of Laplace transforms, The inverse Laplace transforms and examples, Tauberian theorem and Watson's lemma, Laplace transforms of fractional integrals and fractional derivatives, Application of Laplace transforms to ordinary and partial differential equations; initial and boundary value problems and Integral equations; Evaluation of definite integral and solution of difference as well as differential equations.

Finite Laplace Transforms:

Introduction, Definition of finite Laplace transforms with examples, Basic operational properties of finite Laplace transforms, Application of finite Laplace transforms and Tauberian theorem.

Fourier Transforms:

Introduction, Basic concepts and definitions, The Fourier Integral formulae, Definition and examples of Fourier transforms, Basic properties of Fourier transforms, Applications of Fourier transforms to ordinary differential equations; integral equations and partial differential equations, Fourier cosine and sine transforms with examples, Properties of Fourier cosine and sine transforms, Application of Fourier cosine and sine transforms to partial differential equations and evaluation of definite integrals.

Finite Fourier Cosine and Sine Transforms:

Introduction and definition of finite cosine and sine transforms with examples, Basic properties of finite Fourier cosine and sine transforms, Application of finite Fourier cosine and sine transforms.

References:

[1] Integral Transforms and their Applications by Lokenath-Debnath. CRC Publications, 1995.

[2] The Use of Integral Transforms by Inn Sneddon. Tata McGraw Hill Publication, 1979.

[3] Integral Transforms and their Applications by B. Davies. Springer-Verlag, AMS Vol. 25,1978.

[4] Complex Analysis and Laplace Transforms Le Paze TMH Pub.

[5] Integral Transforms by P. K. Gupta Krishna Prakashan Mandir, Meerut, 1990.

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Paper 5006 Advanced Integral Transform

L	P	T	Total
4	0	0	4

Hankel Transforms:

Introduction and definition of Hankel transforms with examples, Operational properties of the Hankel transforms and its application to partial differential equations.

Finite Hankel Transforms:

Introduction and definition of the finite Hankel transforms with examples, Basic operational properties and applications of finite Hankel transforms.

Mellin Transforms:

Introduction and definition of Mellin transforms with examples, Basic operational properties and applications of the Mellin transforms, Mellin transforms of the Weyl fractional integrals and weyl fractional derivatives, Application of Mellin transforms to summation of series

z- Transforms:

Introduction, Dynamic linear systems and Impulse response, Definition of the Z-transforms and examples, Basic operational properties, The inverse Z-transform and examples, Application of Z-transforms to finite difference equations.

Hilbert and Stieltjes Transform:

Introduction and definition of HST with examples, Basic operational properties of HST, Hilbert transform in the complex plane and its applications, Inverse theorem for Stieltjes transform and its application, Asymptotic expansion of the one sided Hilbert transform, The generalized Stieltjes transform, Basic properties of the generalised Stieltjes transforms with applications.

References:

[1] Integral Transforms and their Applications by Lokenath-Debnath. CRC Publication, 1995.
[2] The Use of integral transforms by Inn Sneddon. Tata McGraw Hill, 1979.
[3] Integral Transforms and their Applications' by B. Davies. Springer-Verlag, Vol. 25, 1978.
[4] Mathematical methods in Physical Sciences by Boas M. L.John Wiley & Sons, 1983.
[5] Integral Transforms by Gupta P. K. Krishna Prakashan, Meerut, 1990.

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Paper 5007 Special Functions

L	P	T	Total
4	0	0	4

Infinite Products:

Introduction and definition, Necessary and sufficient condition for convergence, absolute convergence and uniform convergence.

The Gamma and Beta functions:

The Euler or Mascheroni constant , The gamma function, A series for $\frac{\Gamma'(z)}{\Gamma(z)}$, Evaluation of $\Gamma(1)$ and $\Gamma'(1)$, The Euler Product for $\Gamma(z)$, The difference equation $\Gamma(z+1) = z\Gamma(z)$, Euler's integrals for $\Gamma(z)$, The Beta function, The value of $\Gamma(z)\,\Gamma(1-z)$, The factorial function, Legendre's duplication formula , Gauss' multiplication theorem.

The Hyper Geometric Function:

The function F(a,b; c;z), A simple integral formula, F(a,b;c; 1) as a function of parameters, Evaluation of F(a,b;c;1), The continuous function relation, The Hypergeometric differential equations and their logarithmic solutions, Elementary series manipulations, Simple transformations, Relation between function of z and that of (1 - z), A quadratic transformation, Kummar's theorem, Some additional properties.

Bessel's Functions:

Definition of Jn(z), Bessel's differential equation, Differential and pure recurrence relation, Generating functions, Bessel's integrals index half an odd integer, Modified Bessel's functions, Neumann polynimial and Neumann series.

Legendre's Polynomials:

The generating function, Differential and pure recurrence relations, Legendre's differential equation, The Rodrigues formula, Batemann generating function, Additional generating functions, Hypergeometric forms of Pn(x), Brafman's generating function, Properties of Pn(x) with more generating functions, Laplace first integral form, Bounds on Pn(x), Orthogonality theorem, Expausition theorem, expansion of Xn and expansion of analytic functions.

Hermite Polynomials:

Definition of Hn(x), Recurrence relations, Rodrigues formula and generating functions, integrals, Hermite polynomial as a $\{F_0$, orthogonality, Expansion of polynomials and more about generating functions.

References:

[1] Special Functions by Rainville E.D. McMillan, New York, 1960.

[2] Special functions of Mathematical Physics and Chemistry by Sneddon 1. N.Oliver Boyd,1961.

[3] A Treatise on the theory of Bossel's functions by Watson G. N.Cambridge University Press, 193 1.

[4] Special Functions and their Applications by Ledebev N. N. Dover Pub. 1972.

[5] Special Functions by Saxena R. K. and Gokhroo D. C. Khanna Pub.

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Paper 5008 Advanced Special Functions

L	P	T	Total
4	0	0	4

Generalized Hypergeometric functions:

The function pFq The Exponential and Binomial functions, Differential equation and its various solutions, The continuous function relations with simple integral, pF q with unit argument, Saalschutz' theorem, Whipple's theorem, Dixon's theorem, Contour integrals of Barnes' type, The Barnes integrals and the function pFq with some useful integral.

The Confluent Hypergeometr~c Function:

Barie properties of IF I, Kummar's first and second formula.

Generating Functions:

Concept of the generality function, The generating function of the form G(2xt - *e),* Sets generated by e\jf(xt), The generating function A(t)exp["~1/(l-t)], Another class of generating functions and its extension.

Orthogonal Polynomials:

Simple sets of polynomials, Orthogonality and equivalent condition for orthogonality, Zeros of orthogonal polynomials, Expansion of polynomials, The three - term recurrence formula, The Cristoffel - Darbaux formula, Normalization, Bessel's inequality.

Leguerre Polynomials:

A Polynomial $L_n^{(\alpha)}(X)$,Generating functions and recurrence relations, The differential equation, Orthogonality, Expausition of polynomial and special properties, Other generating functions, The simple Leguerre polynomial.

Jacobi Polynomials:

The Jacobi polynomials, Bateman's generating function, The Rodrogues formula and orthogonality, Differential and pure recurrence relations, Mixed relations, Appell's functions of two variables, Elementary generating functions, Brafman's generating functions, Expansion in series of polynomials.

Elliptic Functions:

Doubly periodic function, Elliptic functions, Elementary properties, The Weierstrass function P(z), Differential equation for P(z),

References:

1. Special Functions by Rainville E.D. McMillan, New York, 1960.
2. Special functions of Mathematical Physics and Chemistry by Sneddon I. N.Oliver Boyd, 1961.
3. A Treatise on the theory of Bossel's functions by Watson G. N. Cambridge University Press, 193 1.
4. Special Functions and their Applications by Ledebev N. N. Dover Pub. 1972.
5. Special Functions by Saxena R. K and Gokhroo D. C. Khanna Pub.

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Paper 5021 Computational Fluid Dynamics	**L**	**P**	**T**	**Total**
	4	**4**	**0**	**8**

- Basic Ideas of Computational Fluid Mechanics
- Governing Equations of Fluid Mechanics
- Classification of Quasi-Linear PDEs
- Additional Issues of CFD: Space-Time Resolution of flows
- Discretization of PDEs
- Solution methods for Parabolic PDEs and their Analysis
- Solution methods for Elliptic PDEs Solution of Hyperbolic PDEs Grid Generation
- Finite Difference Methods for PDE & Finite Volume Methods Solution of Navier-Stokes Equation
- ODE and PDE Solver (Practicals)

References:

[1] Anderson: Computational Fluid Dynamics: The Basics with Applications, McGraw Hill.
[2] T K Sengupta: Fundamentals of Computational Fluid Dynamics, University Press.
[3] P. Wesseling: Principles of Computational Fluid Dynamics.
[4] Maurice Holt: Numerical Methods in Fluid Dynamics.
[5] Bosk T K: Computational Fluid Dynamics.

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Paper 5022 - Numerical Analysis & Mathematical Software

L	P	T	Total
4	4	0	8

Understanding MATLAB

- Introduction to MATLAB, Matlab Windows, Symbolic Calculations, Basic Features
- Files and Directory management, File *VO* operations
- Working with Arrays of Numbers
- Matrices and Vectors, Operations on Matrices
- Arithmetic, Relational, Logical, operations, Elementary math functions
- Script and Functions, Sub functions
- Applications in Linear Algebra, Curve Fitting and Interpolation, Numerical
- Integration, Ordinary Differential Equations
- 2-D, 3-D Graphics

Numerical Analysis

- Solution of algebraic and transcendental equations
- Numerical Solution methods for Differential Equations
- Solution of System of Linear Equations: Matrix inversion, Jordan's method
- LU and Cholesky factorizations
- Pivoting, Gauss Elimination method, Jacobi's, Gauss-Seidel method
- Algebraic Eigen Value Problem, Properties of eigen values, eigen vectors, Power method, inverse power method, Given's method, Schur and Gershgorins theorem Least square polynomial approximation
- Numerical Solution of ODE: Runge Kutta methods, Milne Simpsons' method
- Finite Difference Methods for ODE
- System of non-linear equations: Newton Raphson's method.

References:

1. Rudra Pratap, Getting Started with MATLAB - A Quick Introduction for Scientists and Engineers, Oxford University Press, 2004.
2. Duane Hanselman and Bruce Littletied, Mastering Matlab, A Comprehensive tutorial and reference.
3. S. Balachandra Rao, C. K. Shantha, Numerical Methods with Programs in BASIC, FORTRAN, Pascal and C++, University Press.
4. C.E. Froberg, Introduction to Numerical Analysis, Addison Wesley Publishing Company , Sixth Ed., 1981.
5. S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India, New Delh 1997.