



# Government Arts and Science College Ratlam (M. P.) 457001



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For the session 2022-23 the syllabus applied respectively in UG I and II have been adopted from Central Board of Studies Bhopal designed according to NEP2020. For UG III and PG the syllabus of the previous session have been followed.

Principal  
**Principal**  
Govt. Arts and Science College  
Ratlam (M.P.)  
Ratlam (M.P.)

Regular	Private
Theory Marks : 40 C.C.E. Marks : 10	Theory Marks : 50

M.Sc./M.A. Mathematics

**SEMESTER I**

**Paper I Advanced Abstract Algebra - I**

**Unit 1 -**

Automorphisms, Normal and subnormal series of groups, composition series, Jordan-Holder Theorem.

**Unit 2 -**

Commutator subgroup, Solvable series and Solvable groups, Central series and Nilpotent groups.

**Unit 3 -**

Extension fields, Roots of polynomials, Algebraic and transcendental extensions, Splitting fields, Separable and inseparable extensions.

**Unit 4 -**

Perfect fields, Finite fields, Algebraically closed fields.

**Unit 5 -**

Automorphism of extensions, Galois extensions, Fundamental theorem of Galois theory. Solution of polynomial equations by radicals, Insolvability of the general equation of degree 5 by radicals.

**Recommended Books :**

- [1] I. N. Herstein. Topics in algebra, Wiley Eastern Ltd. New Delhi, 1975.
- [2] Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1999.
- [3] P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2<sup>nd</sup> Edition). Cambridge University Press, Indian Edition, 1997.

**Reference Books :**

- [1] N.Jacobson, Basic Algebra, Vols.I & II., W.H.freeman, 1980 (also published by Hindustan Publishing Company).
- [2] S. Lang, Algebra, Addison-Wesley.
- [3] I.S. Luther and I.B.S. Passi, Algebra, Vol.I - Groups, Vol. II - Rings, Narosa Publishing House (Vol. I -1996, Vol.II - 1999 ).

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**M.Sc./M.A. Mathematics**  
**SEMESTER I**

Regular	Private
Theory Marks : 40	Theory Marks : 50
C.C.E. Marks : 10	

**Paper II Real Analysis**

**Unit 1 -**

Definition and existence of Riemann-Stieltjes integral, Properties of integral, integration and differentiation, the fundamental theorem of Calculus.

**Unit 2 -**

Integration of vector valued functions, Rectifiable curves. Rearrangement of terms of a series. Riemann's theorem. Sequences and series of functions, pointwise and uniform convergence.

**Unit 3 -**

Cauchy criterion for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's test for uniform convergence, uniform convergence and continuity, uniform convergence and Riemann-Stieltjes integration, uniform convergence and differentiation, Weierstrass approximation theorem,

**Unit 4 -**

Power series, Uniqueness theorem for power series, Abel's theorem, Functions of several variables, linear transformations, Derivatives in an open subset of  $\mathbb{R}^n$ , chain rule, partial derivatives, interchange of the order of differentiation, derivatives of higher orders. Taylor's theorem,

**Unit 5 -**

Inverse function theorem, Implicit function theorem, Jacobians, Lagrange's multiplier method. Differentiation of integrals, partitions of unity, Differential forms, Stoke's theorem.

**Recommended Books :**

- [1]. Walter Rudin, Principles of Mathematical Analysis (3<sup>rd</sup> edition), McGraw-Hill, Kogakusha, 1976, International Student edition.

**Reference Books :**

- [1] T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.  
 [2] H.L. Royden, Real Analysis, Macmillan Publishing Co. Inc., 4<sup>th</sup> Edition, New York, 1993

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M.Sc./M.A. Mathematics

**SEMESTER I**

**Paper III Topology - I**

Regular	Private
Theory Marks : 40	Theory Marks : 50
C.C.E. Marks : 10	

**Unit 1 -**

Countable and Uncountable sets. Infinite sets and the Axiom of Choice. Cardinal numbers and its arithmetic. Schroeder-Bernstein theorem. Cantor's theorem and the continuum hypothesis. Zorn's lemma. Well - ordering theorem.

**Unit 2 -**

Definition and examples of topological spaces. Closed sets, Closure. Dense subsets. Neighbourhoods. Interior, exterior and boundary. Accumulation points and derived sets.

**Unit 3 -**

Bases and sub bases. Subspaces and relative topology, Product Topology, Metric Topology, Continuous functions and homomorphism.

**Unit 4 -**

First and Second Countable spaces. Covering and Lindelof's spaces. Separable spaces. second countability and Separability.

**Unit 5-**

Connected spaces, connectedness on real line, components, Path connectedness, locally connected spaces.

**Recommended Books :**

[1] James R. Munkres, Topology : A First Course, Prentice Hall of India Pvt. Ltd. New Delhi, 2000.

**Reference Books :**

- [1] K.D. Joshi, Introduction to General Topology, Willey Eastern Limited, 1983.
- [2] George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.
- [3] J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by Prentice-Hall of India Pvt. Ltd.)1111444555566
- [4] N. Bourbaki, General Topology part-I (Transl.) Addison Wesley Reading 1966.
- [5] B. Mendelson, Introduction to Topology, Allyn & Becon, Inc., Boston, 1962.
- [6] E.H. Spanier. Algebraic Topology, McGraw-Hill, New York, 1966.
- [7] J.L. Kelley, General Topology, Van Nostrand, Reinhold Co., New York, 1995.
- [8] M.J. Mansfield, Introduction to Topology, D.Van Nostrand Co. Inc., Princeton, N.J. 1963.

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Regular	Private
Theory Marks : 40	Theory Marks : 50
C.C.E. Marks : 10	

**M.Sc./M.A. Mathematics**  
**SEMESTER I**

**Paper IV. Complex Analysis**

**Unit 1 -**

Complex integration. Cauchy-Goursat Theorem. Cauchy's integral Formula. Higher Order derivatives.

**Unit 2 -**

Morera's Theorem. Cauchy's inequality and Liouville's theorem. The fundamental theorem of Algebra. Taylor's theorem.

**Unit 3 -**

Maximum modulus principle. Schwarz lemma. Laurent's series. Isolated singularities. Meromorphic functions. The argument principle. Rouché's theorem inverse function theorem.

**Unit 4 -**

Möbius Transformations. Fixed Points, Cross Ratio, Bilinear transformations, their properties and classifications. Definitions and Examples of Conformal mappings.

**Unit 5 -**

Residues. Cauchy's residue theorem. Evaluation of integrals. Branches of many valued functions with special reference to  $\arg z$ ,  $\log z$  and  $z^z$ .

**Recommended Books :**

- [1] J.B. Conway, Functions of one Complex variable, Springer-Verlag, International Student Edition, Narosa Publishing House, 1980.
- [2] Brijendra Singh, Varsha Karanjgaokar and R. S. Chandel, Complex Analysis, Gaura Pustak Sadan, Agra - 7.

**Reference Books :**

- [1] S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.
- [2] L.V. Ahlfors, Complex Analysis, McGraw-Hill, 1979.
- [3] B. Singh, Varsha Karanjgaokar and R.S.Chandel, Complex analysis, Golden Valley Publications.


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Regular	Private
Theory Marks : 40	Theory Marks : 50
C.C.E. Marks : 10	

**M.Sc./M.A. Mathematics**  
**SEMESTER I**

**Optional Paper V (ii) Advanced Discrete Mathematics - I**

**Unit 1 -**

Semigroups & Monoids - Definitions and examples of Semigroups and Monoids (including those pertaining to concatenation operation). Homomorphism of semigroups and Monoids. Congruence relation and Quotient Semigroups. Subsemigroup and submonoids. Direct products. Basic Homomorphism Theorem.

**Unit 2 -**

Lattices - Lattices as partially ordered sets. Their properties. Lattices as Algebraic systems. sublattices, Direct products, and Homomorphisms. Some Special Lattices e.g., Complete, Complemented and Distributive Lattices.

**Unit 3 -**

Boolean Algebras-Boolean Algebras as Lattices. Various Boolean Identities. The Switching Algebra example. Subalgebras, Direct products and Homomorphisms. join- irreducible elements. Atoms and Minterms. boolean forms and Their Equivalence. Minterm Boolean forms, Sum of products Canonical forms. Minimization of Boolean Functions. Applications of boolean Algebra to Switching Theory- ( using AND, OR & NOT gates). the Karnaugh Map method.

**Unit 4 -**

Graph Theory- Definition of (undirected) Graphs, Paths, Circuits Cycles & Subgraphs. Induced Subgraphs. Degree of a vertex. Connectivity. Planar Graphs and their properties. Trees.

**Unit 5 -**

Eulers Formula for connected Planar Graphs. Complete & Complete Bipartite Graphs. Kuratowskis Theorem ( statement only) and its use . Spanning trees, cut-sets. Fundamental Cut- Sets, and Cycles. minimal Spanning trees and Kruskals Algorithm. Matrix Representations of Graphs.

**Recommended Books :**

- [1] J.P.Trembly & R.Manohar, Discrete mathematical Structures with Applications to Computer Science, McGraw Hill Book Co. 1997.
- [2] N. Deo, Graph Theory with applications to Engineering and Computer Sciences. Prentice Hall of India.

**Reference Books :**

- [1] J.L.Gersting, Mathematical Structures for Computer Science, (3rd edition), Computer Science Press, New York.
- [2] Seymour Lipschutz, Finite Mathematics (International edition 1983) McGraw- Hill Book Company, New York.
- [3] S. Wiitala, Discrete Mathematics - A Unified Approach, McGraw- Hill Book Co.
- [4] J.E.Hopcroft and J.D. Ullman, Introduction to Automata Theory Languages & Computation Narosa Publishing House.
- [5] B. Singh, R.S.Chandel and Akhilesh Jain, Advanced Discrete Mathematics, Golden Valley Publications.

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Regular	Private
Theory Marks : 40	Theory Marks : 50
C.C.E. Marks : 10	

M.Sc./M.A. Mathematics

**SEMESTER II**

**Paper I Advanced Abstract Algebra - II**

**Unit 1 -**

Introduction to Modules, Examples, Sub-modules and direct sums, Examples of sub-modules, Quotient Modules, R-Homomorphism and Examples of R-Homomorphism ,

**Unit 2 -**

Finitely generated modules. Cyclic modules, Simple modules, Schur's Lemma, Free modules .

**Unit 3 -**

Noetherian and Artinian modules and rings, Hilbert basis theorem.

**Unit 4 -**

Uniform modules, primary modules and Noether-Lasker theorem.

**Unit 5 -**

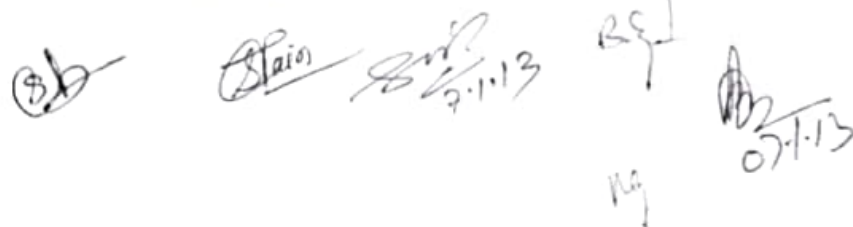
Algebra of linear transformations, Characteristic roots, Similarity of linear transformations. Invariant subspaces, Reduction to triangular forms, Nilpotent transformations, Index of nilpotency, Invariants of a nilpotent transformation, The primary decomposition theorem.

**Recommended Books :**

- [1] I. N. Herstein. Topics in algebra, Wiley Eastern Ltd..New Delhi, 1975.
- [2] Vevek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1999.

**Reference Books :**

- [1] P.B. Bhattacharya, S.K. Jain and S.R..Nagpaul, Basic Abstract Algebra (2<sup>nd</sup> Edition). Cambridge University Press, Indian Edition, 1997.
- [2] S. Kumaresan, Linear Algebra - A geometric approach, Prentice Hall of India. Ltd.


 A collection of handwritten signatures and dates. On the left, a signature 'S.B.' is circled. In the center, a signature 'S.K.' is written above the date '2.1.13'. To the right, there are initials 'B.S.' and 'K.G.' with another date '07.1.13' written below them.

Regular	Private
Theory Marks : 40 C.C.E. Marks : 10	Theory Marks : 50

## M.Sc./M.A. SEMESTER - II

## Paper II Lebesgue Measure and Integration

## Unit 1 -

Lebesgue outer measure. Measurable sets. Regularity. Measurable functions. Borel and Lebesgue measurability. Non-measurable sets.

## Unit 2 -

Integration of Non-negative functions. The General integral. Integration of Series. Riemann and Lebesgue integrals.

## Unit 3 -

The Four derivatives. Functions of bounded variation. Lebesgue Differentiation Theorem. Differentiation and Integration.

## Unit 4 -

The  $L^p$  spaces, Convex functions, Jensen's inequality, Hölder and Minkowski inequalities. Completeness of  $L^p$ .

## Unit 5 -

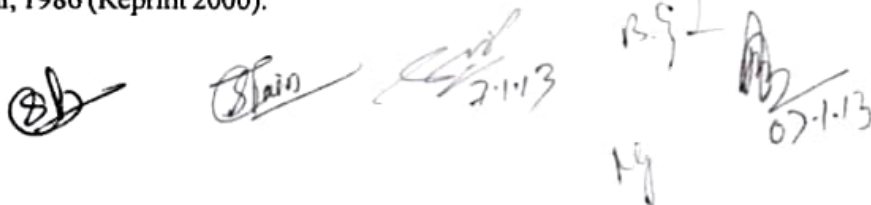
Dual of space, Convergence in Measure, Uniform convergence and Almost uniform convergence.

**Recommended Books :**

[1] G.de Barra, Measure Theory and Integration, Wiley Eastern Limited, 1981.

**Reference Books :**

- [1]. Walter Rudin, Principles of Mathematical Analysis (3<sup>rd</sup> edition), McGraw-Hill, Kogakusha, 1976. International Student edition.
- [2] H.L. Royden, Real Analysis, Macmillan Publishing Co. Inc., 4<sup>th</sup> Edition, New York, 1993
- [3] Inder K. Rana, An Introduction to Measure and Integration, Narosa Publishing House, 1997.
- [4] P.R. Halmos, Measure Theory, Van Nostrand, Princeton, 1950.
- [5] P.K. Jain and V.P. Gupta, Lebesgue Measure and Integration, New Age International (P) Limited Published New Delhi, 1986 (Reprint 2000).


 Several handwritten signatures and dates are present at the bottom of the page. From left to right: a circled signature, a signature that appears to be 'Blain', a date '2-1-13', a signature 'B.S.', a signature 'A', and a date '07-1-13'. There is also a small signature 'Ry' below the 'B.S.' signature.



Max. Marks 50

Regular	Private
Theory Marks : 40	Theory Marks : 50
C.C.E. Marks : 10	

M.Sc./M.A. SEMESTER - II

Paper III Topology - II

Unit 1 -

Separation axioms  $T_0$ ,  $T_1$ ,  $T_2$ ,  $T_3^{1/2}$ ,  $T_4$  their characterization and basic properties. Urysohn's lemma. Tietze extension theorem.

Unit 2 -

Compactness. Continuous functions and compact sets. Basic properties of compactness. Compactness and finite intersection property. Sequentially and countably compact sets. Local Compactness and one point compactification. Stone-Cech compactification.

Unit 3 -

Tychonoff product, Projection maps. Separation axioms and product spaces. Connectedness and product spaces. Compactness and product spaces (Tychonoff Theorem). Embedding lemma and Tychonoff embedding.

Unit 4 -

Nets and Filters. Topology and Convergence of nets. Hausdorffness and nets. Compactness and nets. Filters and their convergence. Canonical way of converting nets to filters and vice versa. Ultrafilters and compactness.

Unit 5 -

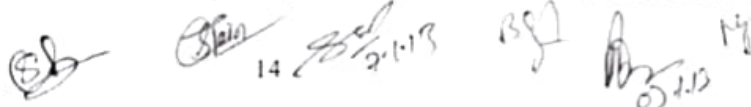
The fundamental group and covering spaces-Homotopy of paths. The fundamental group. Covering spaces. The fundamental group of the circle and the fundamental theorem of algebra.

**Recommended Books :**

- [1] James R. Munkres, Topology : A First Course, Prentice Hall of India Pvt. Ltd. New Delhi, 2000.
- [2] K.D. Joshi, Introduction to General Topology, Willey Eastern Limited, 1983.

**Reference Books :**

- [1] George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.
- [2] J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by Prentice-Hall of India Pvt. Ltd.)
- [3] N. Bourbaki, General Topology part-I (Transl.) Addison Wesley Reading 1966.
- [4] B. Mendelson, Introduction to Topology, Allyn & Becon, Inc., Boston, 1962.
- [5] E.H. Spanier, Algebraic Topology, McGraw-Hill, New York, 1966.
- [6] J.L. Kelley, General Topology, Van Nostrand, Reinhold Co., New York, 1995.
- [7] M.J. Mansfield, Introduction to Topology, D. Van Nostrand Co. Inc., Princeton, N.J. 1963.

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Max. Marks 50

Regular	Private
Theory Marks : 40 C.C.E. Marks : 10	Theory Marks : 50

M.Sc./M.A. SEMESTER - II

Paper IV Complex Analysis - II

Unit 1 -

Weierstrass' factorisation theorem. Gamma function and its properties. Riemann Zeta function. Riemann's functional equation.

Unit 2 -

Runge's theorem. Mittag-Leffler's theorem. Analytic Continuation. Uniqueness of direct analytic continuation. Uniqueness of analytic continuation along a curve. Power series method of analytic continuation.

Unit 3 -

Schwarz Reflection principle. Monodromy theorem and its consequences. Harmonic functions on a disk.

Unit 4 -

Harnack's inequality and theorem. Dirichlet problem. Green's function. Canonical products. Jensen's formula. Poisson - Jensen formula. Hadamard's three circles theorem. Order of an entire function. Exponent of Convergence. Borel's theorem. Hadamard's factorization theorem.

Unit 5 -

The range of an analytic function. Bloch's theorem. The little Picard theorem. Schottky's theorem. Montel Caratheodary and great Picard theorem. Univalent function. Bieberbach conjecture and the  $1/4$  theorem.

**Recommended Books :**

- [1] J.B. Conway, Functions of one Complex variable, Springer-Verlag, International Student Edition, Narosa Publishing House, 1980.

**Reference Books :**

- [1] S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.
- [2] H.A. Priestly, Introduction to complex analysis, Clarendon Press, Oxford, 1990.
- [3] D. Sarason, Complex Function Theory, Hindustan Book Agency, Delhi, 1994.
- [4] E.C. Titchmarsh, The Theory of Functions, Oxford University Press, London.
- [5] L.V. Ahlfors, Complex Analysis, McGraw-Hill, 1979.
- [6] Walter Rudin, Real and Complex Analysis, McGraw-Hill Book Co., 1966.
- [7] S. Saks and Zygmund, Analytic Functions, Monografie matematyczne, 1952.
- [8] B. Singh, Varsha Karanjgoakar and R.S.Chandel, Complex analysis, Golden Valley Publications.

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M.Sc./M.A. SEMESTER - II

Regular	Private
Theory Marks : 40	Theory Marks : 50
C.C.E. Marks : 10	

**Optional Paper V (ii) Advanced Discrete Mathematics - II**

**Unit 1 -**

Directed Graphs. Indegree and Outdegree of a Vertex. Weighted Undirected Graphs. Dijkstra's Algorithms. Strong connectivity and Warshall's Algorithms. Directed Trees. Search Trees. Tree Traversals.

**Unit 2 -**

Introductory Computability Theory- Finite State Machines and their Transition Table Diagrams. Equivalence of Finite State Machines. Reduced Machines. Homomorphism. Finite Automata. Acceptors.

**Unit 3 -**

Non- deterministic finite Automata and equivalence of its power to that of Deterministic Finite Automata Moore and Mealy Machines.

**Unit 4 -**

Turing Machine and Partial Recursive Functions.

Grammars and Languages - Phrase- Structure Grammars. Rewriting Rules. Derivations.

**Unit 5 -**

Sentential forms. Language generated by a Grammar . Regular , Context -Free , and Context Sensitive Grammars and Languages Regular Sets, Regular Expressions and the Pumping Lemma Kleenes Theorem.

Notions of Syntax Analysis. Polish Notations Conversion of Infix Expressions to Polish Notations. The Reverse Polish Notation.

**Recommended Books :**

- [1] J.P.Trembley & R.Manohar, Discrete mathematical Structures with Applications to Computer Science, McGraw Hill Book Co. 1997.
- [2] N. Deo, Graph Theory with applications to Engineering and Computer Sciences, Prentice Hall of India.

**Reference Books :**

- [1] J.L.Gersting, Mathematical Structures for Computer Science. (3rd edition), Computer Science Press, New York.
- [2] Seymour Lipschutz, Finite Mathematics (International edition 1983) McGraw- Hill Book Company, New York.
- [3] S.Wiitala, Discrete Mathematics - A Unified Approach, McGraw- Hill Book Co.
- [4] J.E.Hopcroft and J.D. Ullman, Introduction to Automata Theory Languages & Computation Narosa Publishing House.
- [5] B. Singh, R.S.Chandel and Akhilesh Jain, Advanced Discrete Mathematics, Golden Valley Publications.

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 SB  
 B. Jain  
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 R.S.  
 07.1.13

कक्षा Class : **M.Sc. (Mathematics)**  
 सेमेस्टर Semester : **III**  
 विषय समूह का शीर्षक Title of Subject : **Integration Theory & Functional Analysis-I**  
 Group :  
 प्रश्न पत्र कं. Paper No. : **1**  
 अनिवार्य/ वैकल्पिक Compulsory/ Optional : **Compulsory**

**Unit-1**

Signed measure. Hahn decomposition theorem, mutually singular measures. Radon-Nikodim theorem. Lebesgue decomposition. Riesz representation theorem.

**Unit-2**

Extension theorem (Carathodory), Lebesgue -Stieltjes integral, product measures, Fubini's theorem. Differentiation and Integration.

**Unit-3**

Normed linear spaces. Banach spaces and examples. Quotient space of normed linear spaces and its completeness,

**Unit-4**

Equivalent norms. Riesz lemma, basic properties of finite dimensional linear spaces and compactness.

**Unit-5**

Weak convergence and bounded linear transformations, normed linear spaces of bounded linear transformations, dual spaces with examples.

**Text Books :**

- [1] E. Kreyszig. Introductory Functional Analysis with applications, John Wiley & Sons New York.  
 [2] G.F. Simmons, Introduction to Topology & Modern Analysis Mc Graw Hill, New York.

**Reference :**

- [1] B. Choudhary and Sudarshan Nanda. Functional Analysis with applications, Wiley Eastern Ltd.


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कक्षा Class : **M.Sc. (Mathematics)**  
 सेमेस्टर Semester : **III**  
 विषय समूह का शीर्षक Title of Subject : **Advanced Special Function I**  
 Group : **II(4)**  
 प्रश्न पत्र कं. Paper No. : **4**  
 अनिवार्य/ वैकल्पिक Compulsory/ Optional : **Optional**

## Unit-1

Gamma and Beta Functions : The Euler or Mascheroni Constant  $\gamma$ , Gamma Function, A series for  $\Gamma'(z)/\Gamma(z)$ , Difference equation  $\Gamma(z+1) = z\Gamma(z)$ ,

## Unit-2

Beta function, value of  $\Gamma'(z)\Gamma'(1-z)$ , Factorial Function, Legendre's duplication formula, Gauss multiplication theorem.

Unit-3 Hypergeometric and Generalized Hypergeometric functions: Function  ${}_2F_1(a,b;c;z)$  A simple integral form evaluation of  ${}_2F_1(a,b;c;z)$

Unit-4 Contiguous function relations, Hyper geometrical differential equation and its solutions,  ${}_2F_1(a,b;c;z)$  as function of its parameters.

Unit-5 Elementary series manipulations, Simple transformation, Relations between functions of  $z$  and  $1-z$

## :Books Recommended ;

- 1- Rainville, E.D., ; Special Functions, The Macmillan co., New york 1971,
- 2- Srivastava, H.M. Gupta, K.C. and Goyal, S.P.; The H-functions of One and Two Variables with applications, South Asian Publication, New Delhi.
- 3- Saran, N., Sharma S.D. and Trivedi, - Special Functions with application, Pragati prakashan, 1986.

## Reference Books.

- 1- Lebedev, N.N, Special Functions and Their Applications, Prentice Hall, Englewood Cliffs, New jersey, USA 1995.
- 2- Whittaker, E.T. and Watson, G.N., A Course of Modern Anal

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कक्षा Class : **M.Sc. (Mathematics)**  
 सेमेस्टर Semester : **III**  
 विषय समूह का शीर्षक Title of Subject : **Theory of Linear Operators I**  
 Group : **III(1)**  
 प्रश्न पत्र क्र. Paper No. : **1**  
 अनिवार्य वैकल्पिक Compulsory/ Optional : **Optional**

#### Unit-1

Spectral theory in normed linear spaces, resolvent set and spectrum, Spectral properties of bounded linear operators. Properties of resolvent and spectrum, Spectral mapping theorem for polynomials.

#### Unit-2

Spectral radius of a bounded linear operator on a complex Banach space. Elementary theory of Banach algebras. General properties of compact linear operators. Spectral properties of compact linear operators on normed spaces. Chapter 7,8 (E. Kreyszig).

#### Unit-3

Behaviours of Compact linear operators with respect to solvability of operators equations. Fredholm type theorems. Fredholm alternative theorem. Fredholm alternative for integral equations

#### Unit-4

Spectral properties of bounded self-adjoint linear operators on a complex Hilbert space. Positive operators. Monotone sequence theorem for bounded self-adjoint operators on a complex Hilbert space.

#### Unit-5

Square roots of a positive operator. projection operators. Spectral family of a bounded self-adjoint linear operator and its properties.

#### Recommended Books.

- (1) E. Kreyszig Introductory functional analysis with applications, John Wiley & Sons, New York, 1978.

#### Reference Books:

- (1) P. R. Halmos Introduction to Hilbert space and the theory of Spectral Multiplicity, Second edition, Chelsea publishing co. N.Y. 1957.
- (2) N. Dunford and J.T. Schwartz, linear operator -3 part, Interscience / Wiley, New York 1958-71.
- (3) G. Bachman and L. Narci. Functional analysis. Academic press New York, 1966.

BSL 10/11/12  
 13.6.12  
 13.6.12

कक्षा Class : **M.Sc. (Mathematics)**  
सेमेस्टर Semester : **III**  
विषय समूह का शीर्षक Title of Subject : **Operations Research I**  
Group : **IV(1)**  
प्रश्न पत्र कं. Paper No. : **1**  
अनिवार्य/ वैकल्पिक Compulsory/ Optional : **Optional**

**Unit-i**

Operations Research and its scope, Origin and Development of Operations Research, Necessity of Operations Research in Industry, Characteristics of Operations Research. Model in Operations Research, Phase of Operations Research, Uses and Limitations of Operation Research,

**Unit-2**

Linear Programming Problems, Graphical Solution Method, General Linear Programming Problems, Mathematical Formulation, Graphical Solution Method.

**Unit-3**

Simplex Method exceptional cases, artificial variable techniques ; Big M method, two phase Method , Problem of degeneracy.

**Unit-4 Duality: Fundamental Properties of duality and theorem of duality.**

**Unit-5**

Transportation problems, Assignments problems.

**Recommended Books :-**

1- Kanti Swarup, P.K. Gupta and Manmohan, Operations Research, Sultan Chand & Sons, New Delhi.

**Reference Books:-**

- 1- S.D, Sharma, Operation Research,
- 2- F.S, Hiller and G.J. Lieberman, Industrial Engineering Series, 1995 (This book comes with a CD containing software)
- 3- G. Hadley , Linear Programming, Narosa Publishing House. 1995.
- 4- G. Hadley, Linear and Dynamic programming, Addison - Wesley Reading Mass.
- 5- H.A. Taha, Operations Research - An introduction, Macmillan Publishing co. Inc. New york.
- 6- Prem Kumar Gupta and D.S. Hira, Operation Reasearch, an Introduction, S. Chand & Company Ltd. New Delhi.
- 7- N.S. Kambo, Mathematical Programming Techniques, Affiliated East - West Pvt. Lt

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कक्षा Class : **M.Sc. (Mathematics)**  
 संसेम्टर Semester : **III**  
 विषय समूह का शीर्षक Title of Subject : **Integral Transform I**  
 ग्रुप Group : **V(4)**  
 प्रश्न पत्र कं. Paper No. : **4**  
 अनिवार्य/ वैकल्पिक Compulsory/ Optional : **Optional**

Unit-1

Application of Laplace Transforms

Unit-2

Laplace's equations.

Unit-3

Laplace's wave equation

Unit-4

Application of Laplace Transforms

Unit-5

Heat conduction equation.

Books recommended :-

- [1] Integral Transforms by Goyal & Gupta.
- [2] Integral Transforms by Sneddon

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अधिकतम अंक/Max. Marks 50

कक्षा Class : M.Sc. (Mathematics) Theory Marks : 40

सेमेस्टर Semester : IV C.C.E. Marks : 10

विषय समूह का शीर्षक Title of Subject : Functional Analysis II

Group :

प्रश्न पत्र कं. Paper No. : 1

अनिवार्य/ वैकल्पिक Compulsory/ Optional : Compulsory

Unit-1

Uniform boundedness theorem and some of its consequences. Open mapping and closed graph theorems. Hahn-Banach theorem for real linear spaces.

Unit-2

Complex linear spaces and normed linear spaces. Reflexive spaces. Weak Sequential compactness, Compact operators, Solvability of linear equations in Banach spaces.

Unit-3

The Closed range theorem, Inner product spaces, Hilbert spaces, orthonormal sets, Bessels inequality.

Unit-4

Complete Orthonormal sets and Parseval's identity, Structure of Hilbert spaces. projection theorem. Riesz representation theorem.

Unit-5

Adjoint of an operator on a Hilbert space. Reflexivity of Hilbert spaces. Self-adjoint operators, Positive operators, Projection, and Unitary operators.

Text Books :

- [1] E. Kreyszig, Introductory Functional Analysis with applications, John Wiley & Sons.
- [2] G.F. Simmons, Introduction to Topology & Modern Analysis Mc Graw Hill, New

Reference :

- [1] B. Choudhary and Sudarshan Nanda. Functional Analysis with applications, Wiley Eastem Ltd. .

Handwritten signatures and dates: 2/1/13, B.S., Sain, SB, 07-1-13, M.

कक्षा Class :	M.Sc. (Mathematics)	Theory Marks : 40
सेमेस्टर Semester :	IV	C.C.E. Marks : 10
विषय समूह का शीर्षक Title of Subject :	Advanced Special Function-II	
Group :	II(4)	
प्रश्न पत्र कं. Paper No. :	4	
अनिवार्य/ वैकल्पिक Compulsory/ Optional :	Optional	

## Unit-1

Bessel function and Legendre polynomials : Definition of  $J_n(z)$ , Bessel's differential equation, Generating function, Bessel's integral with index half and an odd integer,

## Unit-2

Generating function for Legendre polynomials Rodrigues formula, Bateman's generating function, Additional generating functions, Hypergeometric forms of  $P_n(X)$ , Special properties of  $P_n(X)$ , Some more generating functions, Laplace's first integral form, Othergonality.

## Unit-3

Special properties of  $P_n(X)$ , Some more generating functions, Laplace's first integral form, Othergonality.

## Unit-4

Definition of Hermite polynomials  $H_n(x)$ , Pure recurrence relations, Differential recurrence relations, Rodrigue's formula, Other generating functions, Othogonality, Expansion of polynomials, more generating functions.

## Unit-5

Laguerre Polynomials : The Laguerre Polynomials  $L_n(X)$ , Generating functions, Pure recurrence relations, Differential recurrence relation, Rodrigo's formula, Orthogonal, Expansion of polynomials, Special properties, Other generating functions.

## Books Recommended ;

- 1- Rainville, E.D. ; Special Functions, The Macmillan co., New york 1971,
- 2- Srivastava, H.M. Gupta, K.C. and Goyal, S.P.; The H-functions of One and Two Variables with applications, South Asian Publication, New Delhi.
- 3- Saran, N., Sharma S.D. and Trivedi, - Special Functions with application, Pragati prakashan, 1986.

## Reference Books.

- 1- Lebedev, N.N, Special Functions and Their Applications, Prentice Hall, Englewood Cliffs, New jersey, USA 1995.
- 2- Whittaker, E.T. and Watson, G.N., A Course of Modern Analysis Cambridge University Press, London, 1963

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अधिकतम अंक/Max. Marks 50

कक्षा Class : M.Sc. (Mathematics) Theory Marks : 40  
सेमेस्टर Semester : IV C.C.E. Marks : 10  
विषय समूह का शीर्षक Title of Subject : Theory of Linear Operators-II  
Group : III(1)  
प्रश्न पत्र कं. Paper No. : 1  
अनिवार्य/ वैकल्पिक Compulsory/ Optional : **Optional**

Unit-1

Spectral representation of bounded self-adjoint linear operators. Spectral theorem. Spectral measures. Spectral Integral.

Unit-2

Regular Spectral Measure. Real and Complex Spectral Measure. Complex Spectral Integral Description of the Spectral Subspaces. Characterization of the Spectral Subspaces.

Unit-3

The Spectral theorem for bounded Normal Operators. Unbounded linear operators in Hilbert space. Hellinger- Toeplitz theorem. Hilbert adjoint operators.

Unit-4

Symmetric and self-adjoint linear operators. Closed linear operators and closures. Spectrum of an unbounded self-adjoint linear operators.

Unit-5

Spectral theorem for unitary and self-adjoint linear operators. Multiplication operator and Differentiation Operator. Chapter 10, E. Kreyszig.

Recommended Books:

- (1) E. Kreyszig Introductory functional analysis with applications, Jhon wiley & Sons, Nwe York, 1978.

Referance Books:

- (1) P. R. Halmos Introduction to Hilbert space and the theory of Spectral Multiplicity, Second edition, Chelsea publishing co. N.Y. 1957.
- (2) N. Dunford and J.T. Schwartz, linear operator -3 part, Interscience / Wiley, New York 1958-71.
- (3) G.Bachman and L. Narci, Functuional analysis, Academic press , 1966

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कक्षा Class : **M.Sc. (Mathematics)** **Theory Marks : 40**  
 सेमेस्टर Semester : **IV** **C.C.E. Marks : 10**  
 विषय समूह का शीर्षक Title of Subject : Operations Research -II  
 Group : **IV(1)**  
 प्रश्न पत्र कं. Paper No. : **I**  
 अनिवार्य/ वैकल्पिक Compulsory/ Optional : **Optional**

**Unit-1**

Network analysis, constraints in Network, Construction of network, Critical Path Method (CPM) PERT, PERT Calculation, Resource Levelling by Network Techniques and advances of network (PERT/CPM).

**Unit-2**

Dynamic Programming - recursive equation approach, Characteristic of Dynamic Programming, Computational procedure, Integer programming Gomory's all I.P.P. method. Branch and Bound Technique.

**Unit-3**

Game theory - Two person Zero-sum games, Maximix-Minimax principle, games without saddle points - Mixed strategies, Graphical solution of  $2 \times n$  and  $m \times 2$  Games, Solution by Linear Programming,

**Unit-4**

Non-linear programming: Mathematical Formulation, General Non-linear Programming Problems, Problems of Constrained Maxima and Minima (Kuhn-Tucker Condition). Non-negative Constraints,

**Unit-5**

Quadratic programming: Wolfe's Modified Simplex method, Beale's Method, Separable programming, Convex programming, Separable programming algorithms.

**Recommended Books :-**

- 1- Kanti Swarup, P.K. Gupta and Manmohan, Operations Research, Sultan Chand & Sons, New Delhi.

**Reference Books:-**

- 1- S.D. Sharma, Operation Research,
- 2- F.S. Hiller and G.J. Lieberman, Industrial Engineering Series, 1995 (This book comes with a CD containing software)
- 3- G. Hadley, Linear Programming, Narosa Publishing House. 1995.
- 4- G. Hadley, Linear and Dynamic programming, Addison - Wesley
- 5- H.A. Taha, Operations Research - An introduction, Macmillan Publishing co. Inc. .
- 6- Prem Kumar Gupta and D.S. Hira, Operation Research, an Introduction, S. Chand & Company Ltd.
- 7- B.Singh, Varsha Karanjgaokar and R. S. Chandel, Operations Research, Golden Valley Publications.

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कक्षा Class : M.Sc. (Mathematics)  
सेमेस्टर Semester : V  
विषय समूह का शीर्षक Title of Subject : Integral Transform-II  
Group : V(4)  
प्रश्न पत्र कं. Paper No. : 4  
अनिवार्य/ वैकल्पिक Compulsory/ Optional : **Optional**

अधिकतम अंक/Max. Marks 50  
Theory Marks : 40  
C.C.E. Marks : 10

Unit-1

Application of Laplace Transform to Boundary Value Problems.

Unit-2

Electric Circuits. Application to Beams.

Unit-3

The complex Fourier Transform, Inversion Formula, Fourier cosine and sine transform,

Unit-4

properties of Fourier Transforms, Convolution & Parseval's identity

Unit-5

Fourier Transform of the derivatives, Finite Fourier Sine & Cosine Transform, Inversion Operational and combined properties Fourier transform.

Books recommended :-

- [1] Integral Transforms by Goyal & Gupta.
- [2] Integral Transforms by Sneddon

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