

BARKATULLAH UNIVERSITY, BHOPAL

| | | |
|-------------|---|------------------------------|
| Class | - | M.Sc/M.A. |
| Semester | - | I |
| Subject | - | Mathematics |
| Paper Title | - | Advanced Abstract Algebra -I |
| Paper | - | I |

Max. Marks : 85

- Unit-1** Normal & Subnormal series of groups, Composition series, Jordan-Holder series.
- Unit-2** Solvable & Nilpotent groups.
- Unit-3** Extension fields. Roots of polynomials, Algebraic and transcendental extensions. Splitting fields. Separable and inseparable extension.
- Unit-4** Perfect fields, Finite fields, Algebraically closed fields.
- Unit-5** Automorphism of extension, Galois extension. Fundamental theorem of Galois theory Solution of polynomial equations by radicals, Insolubility of general equation of degree 5 by radicals.

Text books :-

- (1) I.N. Herstein, Topics in Algebra, Wiley Eastern, New Delhi.
- (2) V.Sahai & V. Bisht, Algebra, Narosa Publishing House.
- (3) P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra, Cambridge University press.

Reference Books :-

- (1) N. Jacobson, Basic Algebra, Vol. I, II & VIII, Hindustan Publishing Company.
- (2) S. Lang, Algebra, Addison- Wesley.
- (3) I.S. Luther & I.B.S. Passi Algebra vol-1,2,3 Narosa company.

Books prescribed in unified syllabus.

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|-------------|---|------------------------------|
| Class | - | M.Sc/M.A. |
| Semester | - | II |
| Subject | - | Mathematics |
| Paper Title | - | Advanced Abstract Algebra-II |
| Paper | - | I |

Max. Marks : 85

- Unit-1** Introduction to Modules, examples, submodules, quotient modules, Module homomorphism, isomorphism, Finitely generated modules, cyclic modules.
- Unit-2** Simple modules, Semisimple modules, Free modules, Schur's lemma.
- Unit-3** Noetherian & Artinian modules and rings, Hilbert basis theorem. Wedderburn -Artin theorem.
- Unit-4** Uniform modules, Primary modules, Noether-Laskar theorem, Fundamental structure theorem of modules over a principal ideal domain.
- Unit-5** Algebra of Linear Transformation, characteristic roots, Matrices, Matrix of Linear Transformations, similarity of Linear transformation, Invariant spaces, Reduction to triangular forms.

Text book :

- (1) P.B. Bhattacharya, S.K. Jain, S.R. Nagpaul, Basic Abstract Algebra, Cambridge University Press, (Indian Edition)
- (2) I.N. Herstein, Topics in Algebra, Wiley Eastern.
- (3) S. Kumaresan, Linear Algebra-A geometric approach, Prentice Hall India Ltd.
- (4) Books prescribed in unified syllabus.

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|-------------|---|---------------|
| Class | - | M.Sc/M.A. |
| Semester | - | I |
| Subject | - | Mathematics |
| Paper Title | - | Real Analysis |
| Paper | - | II |

Max. Marks : 85

- Unit-I** Definition and existence of Riemann- Stieltjes integral and its properties, Integration and differentiation.
- Unit-II** Integration of vector- valued functions, Rectifiable curves. Rearrangements of terms of a series. Riemann's theorem.
- Unit-III** Sequences and series of functions, Point wise and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass M-test, uniform convergence and continuity, uniform convergence and Riemann-Stieltjes integration, uniform convergence and differentiation.
- Unit-IV** Functions of several variables, linear transformations, Derivatives in an open subset of R^n , Chain rule, Partial derivatives, Differentiation, Inverse function theorem.
- Unit-V** Derivatives of higher order, Power series, uniqueness theorem for power series, Abel's and Tauber's theorems, Implicit function theorem,

Text books :

1. Walter Rudin, Principles of Mathematical Analysis, McGraw Hill.

Reference books:

1. T.M. Apostol, Mathematical Analysis Narosa.
2. H.L. Royden, Real Analysis, Macmillan (Indian Edition)
3. Books prescribed in unified syllabus.

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| | | |
|-------------|---|--------------------------------|
| Class | - | M.Sc/M.A. |
| Semester | - | II |
| Subject | - | Mathematics |
| Paper Title | - | Lebesgue Measure & Integration |
| Paper | - | II |

Max. Marks : 85

- Unit -I** Lebesgue outer measure. Measurable sets. Regularity. Measurable functions. Borel and Lebesgue measurability. Non-measurable sets.
- Unit - II** Integration of Non-negative functions. The General integral. Integration of Series, Reimann and Lebesgue Integrals.
- Unit - III** The Four derivatives. Functions of Bounded variation. Lebesgue Differentiation Theorem, Differentiation and Integration.
- Unit - IV** The L^p -spaces, Convex functions, Jensen's inequality. Holder and Minkowski inequalities. Completeness of L^p .
- Unit - V** Dual of space when $1 < p < \infty$, convergence in measure, Uniform. Convergence and almost uniform convergence.

Text book :

1. G. de Barra. Measure Theory and Integration, Wiley Eastern (Indian Edition)

References Books:

1. Walter Rudin, Principles of Mathematical Analysis, McGraw-Hill, International student edition,
2. H.L. Royden, Real Analysis, Macmillan, Indian Edition.
3. Books prescribed in unified syllabus.

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| | | |
|-------------|---|-------------|
| Class | - | M.Sc/M.A. |
| Semester | - | I |
| Subject | - | Mathematics |
| Paper Title | - | Topology-I |
| Paper | - | III |

Max. Marks : 85

- Unit - I** Countable and uncountable sets. Infinite sets and the Axiom of Choice. Cardinal numbers and its arithmetic. Schroeder-Bernstein theorem, statements of Cantor's theorem and the Continuum hypothesis. Zorn's lemma. well- ordering theorem. [G.F. Simmons and K.D. Joshi]
- Unit- II** Definition and examples of topological spaces. Closed sets. Closure. Dense subsets. Neighbourhoods, interior exterior and boundary. Accumulation points *and* derived sets. Bases and sub-bases, Subspaces and relative topology. [G.F. Simmons]
- Unit-III** Alternate methods of defining a topology in terms of Kuratowski Closure Operator and Neighbourhood Systems. Continuous functions and homeomorphism. [G.F. Simmons, K.D. Joshi, J.R. Munkers]
- Unit- IV** First and Second Countable spaces. Lindelof's theorems. Separable spaces. Second Countability and Separability. [G.F., Simmons]
- Unit- V** Path-connectedness, connected spaces. Connectedness on Real line. Components, Locally connected spaces. [J.R. Munkers]

Text Books:-

1. J.R. Munkers, Topology-A first course, Prentice-Hall of India.
2. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill
3. K.D. Joshi: Introduction to General Topology, Wiley Eastern.

Books prescribed in unified syllabus.

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| | | |
|-------------|---|--------------|
| Class | - | M.Sc/M.A. |
| Semester | - | II |
| Subject | - | Mathematics |
| Paper Title | - | Topology -II |
| Paper | - | III |

Max. Marks : 85

- Unit - I** Separation Axioms T_0, T_1, T_2, T_3, T_4 Their Characterizations and basic properties, Urysohn's lemma. Tietze Extension Theorem. [K.D. Joshi, G.F. Simmons]
- Unit - II** Compactness. Continuous functions and compact sets. Basic properties of compactness. Compactness and finite intersection property. Sequentially and countably compact sets, Local compactness. [G.F. Simmons]
- Unit -III** Tychonoff product topology in terms of standard sub-base and its characterizations. Projection maps. Separation axioms and product spaces, Connectedness and product spaces, Compactness and product spaces (Tychonoff's theorem) Countability and product spaces. [G.F. Simmons]
- Unit - IV** Net and filter's 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. [K.D. Joshi]
- Unit -V** 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. [J.R. Munkers]

Text books :-

1. James R. Munkres, Topology, A First Course, Prentice Hall of India Pvt. Ltd. New Delhi.
2. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company.
3. K.D. Joshi, Introduction to general topology Wiley Eastern Ltd.
4. Books prescribed in unified syllabus.

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| | | |
|-------------|---|--------------------|
| Class | - | M.Sc/M.A. |
| Semester | - | I |
| Subject | - | Mathematics |
| Paper Title | - | Complex Analysis-I |
| Paper | - | IV |

Max. Marks : 85

- Unit-I** Complex integration, Cauchy - Goursat theorem, Cauchy integral formula, Higher order derivatives
- Unit-II** Morera's theorem. Cauchy's inequality. Liouville's theorem. The fundamental theorem of algebra. Taylor's theorem.
- Unit-III** The maximum modulus principle. Schwartz lemma. Laurent series. Isolated singularities. Meromorphic functions, The argument principle. Rouché's theorem. Inverse function theorem.
- Unit - IV** Residues. Cauchy's residue theorem. Evaluation of integrals. Branches of many valued functions with special reference to $\arg z, \log z, z^a$.
- Unit - V** Bilinear transformations, their properties and classification. Definitions and examples of conformal mappings.

Text Book :

1. J.B. Conway, Functions of one complex variable, Springer-verlag

Reference Books:

1. S. Ponnuswamy, Foundations of complex analysis, Narosa Publishing House.
2. L.V. Ahlfors, Complex analysis, McGraw Hill
3. Books prescribed in unified syllabus.

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|-------------|---|----------------------|
| Class | - | M.Sc/MA |
| Semester | - | II |
| Subject | - | Mathematics |
| Paper Title | - | Complex Analysis -II |
| Paper | - | IV |

Max. Marks : 85

- Unit - I** Weierstrass factorization theorem. Gamma and its properties. Riemann Zeta function. Riemann's functional equation
- Unit - II** 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 - III** Schwartz reflection principle. Harmonic function on a disc. Harnax inequality and theorem. Dirichlet problem. Green's function.
- Unit-IV** Cannonical products. Jensen's formula. Hadamard's three circles theorem. Order of an entire function. Exponent of convergence. Borel's theorem Hadamard's factorization theorem.
- Unit-V** 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 $\frac{1}{4}$ - theorem.

Text Book.:-

1. J.B. Conway, Functions of one complex variable, Springer-Verlag

Reference

1. S Ponnuswamy, Fundamentals of complex analysis, Narosa Publishing House.
2. L.V. Ahlfors, Complex Analysis, McGraw Hill

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|-------------|---|---------------------------------|
| Class | - | M.Sc/M.A. |
| Semester | - | I |
| Subject | - | Mathematics |
| Paper Title | - | Advanced Discrete Mathematics-I |
| Paper | - | V (optional-I) |

Max. Marks : 85

Unit-I Semigroups and monoids, subsemigroups and submonoids, Homomorphism of semigroups and monoids, Congruence relation and Quotient semigroups, Direct products, Basic Homomorphism Theorem.

Unit-II Lattices- Lattices as partially ordered sets, their properties, Lattices as Algebraic systems, sublattices, Bounded lattices, Distributive Lattices, Complemented lattices.

Unit-III Boolean Algebra- Boolean Algebras as lattices, various Boolean identities. Joint irreducible elements, minterms, maxterms, minterm Boolean forms, canonical forms, minimization of Boolean functions. Applications of Boolean Algebra to switching theory (Using AND, OR, & NOT gates) the Karnaugh method.

Unit-IV Graph Theory- Definition and types of graphs. Paths & circuits. Connected graphs. Euler graphs, weighted graphs (undirected) Dijkstra's Algorithm. Trees, Properties of trees, Rooted & Binary trees, spanning trees, minimal spanning tree.

Unit-V Complete Bipartite graphs, Cut-sets, properties of cut sets, Fundamental Cut-sets & circuits, Connectivity and Separability, Planar graphs, Kuratowski's two graphs, Euler's formula for planar graphs.

Text Books :-

1. J.P. Tremblay & R. Manohar, Discrete Mathematical structures,

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|-------------|---|-----------------------------------|
| Class | - | M.Sc/M.A. |
| Semester | - | II |
| Subject | - | Mathematics |
| Paper Title | - | Advanced Discrete Mathematics -II |
| Paper | - | V (Optional-I) |

Max. Marks : 85

- Unit-I** Matrix representation of graphs- Incidence matrix, Cut set matrix, Path Matrix, Circuit Matrix and Adjacency matrix. Directed graphs Definition of types of directed graphs, Binary search trees.
- Unit-II** Discrete Numeric functions, Asymptotic Behaviour of Numeric functions, Generating functions. Recurrence Relations- Linear Recurrence Relations with constant coefficients, Homogeneous solutions, particular solutions, Total Solutions.
- Unit-III** Computability and Formal languages- Languages, Phrase structure grammars, Derivation, Sentential forms, Language generated by grammar. Regular, context-free and context sensitive grammars.
- Unit-IV** Finite State Automata, Diagram & Language determined by an Automaton, Finite State Acceptors, Deterministic and Non-deterministic Finite Automata. Finite State Machines, their transition tables & diagrams. Equivalent machines.
- Unit-V** Reduced Machines, Kleen's theorem (Statement only) Pumping lemma, Moore and Mealy Machines, Turning Machines. Regular Expressions and corresponding regular languages (Def only)

BARKATULLAH UNIVERSITY, BHOPAL

Class : M.Sc.
Semester : III
Subject : Mathematics
Paper : Compulsory
Paper Title : Functional Analysis-I

Max. Marks : 85

- Unit-I** Normed linear spaces. Banach Spaces and examples. Properties of normed linear spaces, Basic properties of finite dimensional normed linear spaces.
- Unit-II** Normed linear subspace, equivalent norms, Riesz lemma and compactness. Quotient space of normed linear spaces and its completeness.
- Unit-III** Linear operator, Bounded linear operator and continuous operators.
- Unit-IV** Linear functional, bounded linear functional, Dual spaces with examples.
- Unit-V** Hilbert space, orthogonal complements, orthonormal sets and sequences. Representation of functional on Hilbert spaces.

Text Books :

1. E. Kreyszig, Introductory functional analysis with application, Jhon Wiley & sons. New York 1978.
2. G.F. Simmons, Introduction to Topology & Modern Analysis, Tata Mc Graw Hill, New York.

Reference :-

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

BARKATULLAH UNIVERSITY, BHOPAL

Class : M.Sc./M.A.
Semester : IV
Subject : Mathematics
Paper Title : Functional Analysis-II
Paper : Compulsory

Max. Marks : 85

Unit-I Hilbert adjoint operator and its properties, self adjoint, Unitary and normal operators positive operator.

Unit-II Zorn's Lemma Hahn-Banach Theorem for real linear spaces, Hahn-Banach theorem for complex linear space and normed linear spaces.

Unit-III Adjoint operators on normed spaces, relation between adjoint operator and Hilbert adjoint operator, Reflexive spaces, Reflexivity of Hilbert space.

Unit-IV Category theorem- Baire's Category theorem, uniform boundedness theorem and some of its application, strong and weak convergence in normed spaces.

Unit-V Convergence of sequences of operators and functionals, open mapping theorem, closed graph theorem, contraction theorem.

Text Books :

1. E. Kreyszig, Introductory Functional Analysis with applications, John Wiley & Sons, New York 1978.
2. G.F. Simmons, Introduction to Topology & Modern Analysis McGraw Hill, New York.

Reference :

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

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|--------------------|---|----------------------------------|
| Class | : | M.Sc./M.A. |
| Semester | : | III |
| Subject | : | Mathematics |
| Paper Title | : | Advanced Graph Theory – I |
| Paper | : | Optional -III |

Max. Marks : 85

- Unit-I** Revision of graph theoretic preliminaries. Isomorphism of graphs, subgraphs.
- Unit-II** Walks, Paths and circuits, Connected graphs, Disconnected graphs and components, Euler Graphs, Operations on Graphs, Hamiltonian paths and circuits, The traveling salesman problem.
- Unit-III** Trees, Properties of trees, Distance and centers in a tree, Rooted and Binary trees, Spanning trees, Fundamental circuits, spanning trees in a weighted graph.
- Unit-IV** Cut-sets, Properties of a cut-set, Fundamental circuits and cut-sets, connectivity and separability.
- Unit-V** Planar graphs, Kuratowski's two graphs, Different Representations of a planer graph, Detection of Planarity, Geometric Dual, Combinational Dual.

Text Book :-

Graph theory with applications to Engineering and Computer Science by Narsingh Deo. Prentice Hall of India.

Reference books :-

Graph theory by Harary.

BARKATULLAH UNIVERSITY, BHOPAL

Class : M.Sc./M.A.
Semester : IV
Subject : Mathematics
Paper Title : Advanced Graph Theory- II
Paper : Optional -III

Max. Marks : 85

- Unit-I** (Matrix representation of graphs, Incidence matrix, Submatrices of $A(G)$, Circuit Matrix, Fundamental circuit matrix) and Rank of B , An application to a switching Network.
- Unit-II** Cut-set Matrix, Relationships among A_f , B_f and C_f , path matrix, Adjacency matrix.
- Unit-III** Chromatic Number, chromatic Partitioning, chromatic Polynomial, (Coverings, matching's).
- Unit-IV** The four color problem, directed graph, some types of Digraphs, Digraphs and Binary relations, Euler digraphs, Directed paths and connectedness.)
- Unit-V** Trees with directed graphs, Arboreocence, Fundamental Circuits in Digraphs. Matrix A , B and C of Digraphs, Adjacency matrix of a Digraph.

Text Book :-

Graph theory with applications to Engineering and computer science by Narsingh Deo.

Reference Book :-

Graph theory by Harary

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| Class | : | M.Sc./M.A. |
| Semester | : | III |
| Subject | : | Mathematics |
| Paper Title | : | Theory of Linear Operators-I |
| Paper | : | Optional -V |

Max. Marks : 85

- Unit-I** Spectral Theory in finite dimensional normed spaces. Regular value resolvent set and spectrum.
- Unit-II** Spectral Properties of Bounded Linear Operators, resolvent and spectral mapping theorem for polynomials.
- Unit-III** Spectral radius of a bounded linear operator on a complex Banach space. Banach Algebra, Further properties of Banach Algebras.
- Unit-IV** Compact linear operators on normed spaces, further properties of compact linear operators.
- Unit-V** Spectral properties of compact linear operators.

Text Books :

1. E. Kreyszig, Introductory functional analysis with application, Jhon Wiley & sons. New York 1978.
2. G.F. Simmons, Introduction to Topology & Modern Analysis, Tata McGraw Hill, New York.

Reference :-

1. P.R. Halmos, Introduction to Hilbert space and the theory of spectral Multiplicity, second Edition, Chelsea Publishing Co. N.Y. 1957.
2. N. Dund Ford and J.T. Schwartz, Linear operator-3 part inter science/Wiley New York, 1958-71.
3. G. Bachman and L. Narcil, Functional analysis form acadmic press New York 1966.

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Class : M.Sc./M.A.
Semester : IV
Subject : Mathematics
Paper Title : Theory of Linear Operators-II
Paper : Optional -V

Max. Marks : 85

Unit-I Further spectral properties of compact linear operators, Operator Equation involving compact linear operators,

Unit-II Further theorems of Fredholm type, Bi-orthonormal system, Fredholm Alternative, Equicontinuous sequence, compact integral operator.

Unit-III Spectral properties of Bounded Self-Adjoint linear operators, Further Properties of Bounded Self-Adjoint linear operators.

Unit-IV Positive operators : Product of positive operators, monotone sequences of bounded self adjoint operators, square roots of positive operator.

Unit-V Projection Operators : Product and sum of projections. Further properties of projections.

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|----------------|---|-----------------------|
| Class | : | M.Sc. /M.A. |
| Semester | : | III |
| Subject | : | Mathematics |
| Paper Title | : | Operations Research-I |
| Optional Group | : | Optional -VIII |

MM- Theory – 85

- Unit-1** Operations Research and its scope, Origin and Development of Operations Research, Characteristics of Operations Research,
- Unit-2** Model in Operations Research, Phase of Operations Research, Uses and Limitations of Operation Research, Linear Programming Problems.
- Unit-3** Mathematical Formulation, Graphical Solution Method.
- Unit-4** General Linear Programming Problem : Simplex Method exceptional cases, artificial variable techniques ; Big M method, two phase Method and Cyclic Problems, problem of degeneracy.
- Unit-5** Duality, Fundamental Properties of duality and theorem of duality.

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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Class : M.Sc./M.A.
Semester : IV
Subject : Mathematics
Paper Title : Operations Research-II
Paper : Optional - VIII

Max. Marks : 85

Unit-I Transportation problems : North- West Corner Method
Least-Cost Method. Vogel's Approximation Method, MODI
Method. Exceptional cases and problem of degeneracy.

Unit-II Assignment problems, Non-Linear Programming
Techniques-Kuhn-Tucker Conditions, Non-negative
constraints.

Unit-III Network analysis, constraints in Network, Construction of
network, Critical Path Method (CPM) PERT, PERT
calculation, Resource Leveling by Network Techniques and
advances of network (PERT/CPM).

Unit-IV Simulation : Monte-Carlo Simulation. Simulation of
Networks, Advantage and Limitation of Simulation.

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

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|-------------|---|----------------------|
| Class | : | M.Sc. /M.A. |
| Semester | : | III |
| Subject | : | Mathematics |
| Paper Title | : | Integral Transform-I |
| Paper | : | Optional -X |

Max. Marks : 85

- Unit-I** Laplace Transform, Inverse Laplace Transform. Transforms of derivatives, shifting theorem, convolution Theorem.
- Unit-II** Application to Differential Equations, Application to Integral equations. Solution of simulates differential equations.
- Unit-III** Laplace Equation in two dimension, Wave Equation in one dimension Application to wave equation.
- Unit-IV** Application of Laplace Transform to electrical circuits, Application to Beams.
- Unit-V** Heat conduction equation in one dimension, Application to heat conduction equation.

Books Recommended :-

1. Integral Transforms by Goyal and Gupta
2. Integral Transform by Sneddon.

BARKATULLAH UNIVERSITY, BHOPAL

Class : M.Sc./M.A.
Semester : IV
Subject : Mathematics
Paper Title : Integral Transform-II
Paper : Optional -X

Max. Marks : 85

- Unit-I** Fourier Transform, Infinite Fourier transform, Complex Fourier transform.
- Unit-II** Finite Fourier Transform and Fourier Integral.
- Unit-III** Convolution theorem, Parseval's Identity for Fourier series, Parseval's Identity for Fourier transform.
- Unit-IV** Application for Fourier Transform to Boundary value problems.
- Unit-V** Introduction to Hankel and Mellin Transforms, Fourier Series and Boundary value problems.

Books Recommended :-

1. Integral Transforms by Goyal and Gupta.
2. Integral Transform by I.N. Sneddon.
3. Integral transform by Gupta and Vashishtha.