Directorate of Distance Learning Education

Scheme of Studies

MASTER OF SCIENCE IN MATHEMATICS
From 2012 and onwards

DEPARTMENT OF MATHEMATICS

GOVERNMENT COLLEGE UNIVERSITY, FAISALABAD
# M.Sc Mathematics

## SEMESTER- I

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>MTH-551</td>
<td>Real Analysis-I</td>
<td>4(4-0)</td>
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<tr>
<td>MTH-553</td>
<td>Complex Analysis</td>
<td>4(4-0)</td>
</tr>
<tr>
<td>MTH-555</td>
<td>Vector and Tensor</td>
<td>4(4-0)</td>
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<tr>
<td>MTH-557</td>
<td>Algebra-I</td>
<td>4(4-0)</td>
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<td>MTH-559</td>
<td>Point Set Topology</td>
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## SEMESTER-II

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<tbody>
<tr>
<td>MTH-552</td>
<td>Real Analysis-II</td>
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<td>MTH-554</td>
<td>Algebra-II</td>
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<td>MTH-556</td>
<td>Mechanics</td>
<td>4(4-0)</td>
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<td>MTH-558</td>
<td>Functional Analysis</td>
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<td>MTH-560</td>
<td>Differential Geometry</td>
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## SEMESTER- III

### PURE MATHEMATICS

#### COMPULSORY

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<tbody>
<tr>
<td>MTH-651</td>
<td>Advanced Group Theory</td>
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<tr>
<td>MTH-653</td>
<td>Advanced Set Theory</td>
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**Optional Paper (3 out of Following)**

<table>
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<tbody>
<tr>
<td>MTH-655</td>
<td>Mathematical Statistics- I</td>
<td>4(4-0)</td>
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<tr>
<td>MTH-657</td>
<td>Continuous Groups</td>
<td>4(4-0)</td>
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<tr>
<td>MTH-659</td>
<td>Theory of Modules</td>
<td>4(4-0)</td>
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<td>MTH-661</td>
<td>Algebraic Topology</td>
<td>4(4-0)</td>
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<tr>
<td>MTH-663</td>
<td>Advanced Topology</td>
<td>4(4-0)</td>
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<td>MTH-665</td>
<td>Numerical Analysis-I</td>
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<td>MTH-667</td>
<td>Linear Algebra</td>
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<tr>
<td>MTH-669</td>
<td>Rings and Fields</td>
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### APPLIED MATHEMATICS

#### SEMESTER- IV

#### PURE MATHEMATICS

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<tr>
<td>MTH-668</td>
<td>Fluid Mechanics-II</td>
<td>4(4-0)</td>
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<tr>
<td>MTH-670</td>
<td>Partial Differential Equations</td>
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#### APPLIED MATHEMATICS

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<th>Credit Hours</th>
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<tr>
<td>MTH-672</td>
<td>Theory of Elasticity</td>
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<td>MTH-674</td>
<td>Electromagnetism</td>
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<td>MTH-660</td>
<td>Mathematical Statistics-II</td>
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<td>MTH-662</td>
<td>Numerical Analysis-II</td>
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<td>MTH-664</td>
<td>Theory of Optimization</td>
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<td>MTH-666</td>
<td>Special Functions</td>
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<td><strong>Total</strong></td>
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REAL ANALYSIS-I


BOOKS RECOMMENDED

<table>
<thead>
<tr>
<th>Course Number</th>
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<th>Credit Hours</th>
<th>Marks</th>
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<tbody>
<tr>
<td>MATH-712</td>
<td>Complex Analysis</td>
<td>4(4-0)</td>
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**COMPLEX ANALYSIS**


**BOOKS RECOMMENDED**

4. J. Paliouras, *Complex Variables for Scientists and Engineers* McMillan
VECTOR AND TENSOR

VECTOR ANALYSIS

Curvilinear Coordinates, Scale Factors, Arc length, Area and volume in curvilinear coordinates. Spherical and Cylindrical coordinates, Expansion formulas of Gradient, Divergence and Curl of point in curvilinear coordinate, Relation between orthogonal bases, Curvilinear Coordinates, Spherical and cylindrical coordinates and their applications, Line, Surface and volume integral. Gausses, Green’s and Stokes theorem with their application.

CARTESIAN TENSORS


BOOKS RECOMMENDED

5. Dr. Nawzish Ali Shah *Vector and Tensor Analysis*
<table>
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<th>Course Number</th>
<th>Title</th>
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<td>MATH-714</td>
<td>Algebra-I</td>
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</table>

**ALGEBRA –I**


**BOOKS RECOMMENDED**

POINT SET TOPOLOGY


BOOKS RECOMMENDED

REAL ANALYSIS-II


BOOK RECOMMENDED

6. Apostol, Mathematical Analysis 6th Prenteng Addison-wesley Publicating company.
<table>
<thead>
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<th>Course Number</th>
<th>Title</th>
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<th>Marks</th>
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<tr>
<td></td>
<td>Algebra-II</td>
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</table>

**ALGEBRA –II**


**BOOKS RECOMMENDED**

2. S. Lang, *Linear Algebra*, Addison-Wesley.
MECHANICS

General Motion of a rigid body, Euler’s Theorem and Chasles Theorem. Euler’s Angles, Moments and Products of Intertia, Intertia Tensor, Euler’s Principal Axes and Principal Moments of Inertia, Kinetic Energy and Angular Momentum of a Rigid Body, Momental Ellipsoid and Equimomenttal Systems, Euler’s dynamical Equations and their solution in special cases. Heavy asymmetrical Top, Equilibrium of a Rigid Body, General Conditions of Equilibrium, and Deduction of Conditions in Special Cases.

BOOKS RECOMMENDED

5. F. Chorlton, *A Text Book of Dynamics*.
Course Number | Title                  | Credit Hours | Marks |
-------------|------------------------|--------------|-------|
MATH-724     | Functional Analysis    | 4(4-0)       | 80    |

FUNCTIONAL ANALYSIS


RECOMMENDED BOOKS

Differential Geometry

The moving trihedron, Arc length parameter representations; The osculating plane, The osculating circle analysis and the osculating sphere; Curvature and torsion of unit speed and non unit speed curves, Serret-Frenet formulae. Helices, Spherical indicatericies, Evolutes. The theory of surfaces: Simple surface and coordinate patches. The tangent plane and the normal planes, the first fundamental form and the metric, Coordinate transformations. Surface curves: the angle between two curves on a surface; Normal curvature Analysis and geodesic curvature, The second fundamental form, Christoffel symbols. Gauss theorem. Mean and Gauss Ian curvatures, Principal curvatures, Asymptotic and principal direction, Euler’s theorem, Dupin’s indicatericies. The Gauss-Weingarten, Guass-Codazzi equations.

Books Recommended


<table>
<thead>
<tr>
<th>Course Number</th>
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<th>Credit Hours</th>
<th>Marks</th>
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<tbody>
<tr>
<td>MATH-725</td>
<td>Differential Geometry</td>
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**ADVANCED GROUP THEORY**

Introduction to Sets and Structures. Examples of groups. Finite groups. Subgroups. Permutations and cyclic groups. Isomorphism’s and Homomorphism with separate reference to Abelian groups. Cosets, Normal groups, Factor groups and Simple groups. Series of groups. The Sylow theorems. Groups actions, Free groups and group presentations, Geometric, Analytic and dynamical applications. A brief introduction to continuous groups and group representations.

**RECOMMENDED BOOKS**

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Title</th>
<th>Credit Hours</th>
<th>Marks</th>
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<tbody>
<tr>
<td>MATH-732-P</td>
<td>Advanced Set Theory</td>
<td>4(4-0)</td>
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</table>

**ADVANCED SET THEORY**

Equivalent sets, Countable and uncountable sets, The concept of cardinal number, Addition and multiplication of cardinals, Cartesian products as sets of function, Addition and multiplication of ordinals. Partially ordered sets axiom of choice, statement of lemma.

**LEBESGUE MEASURE**


**BOOKS RECOMMENDED**

Course Number | Title                        | Credit Hours | Marks
-------------|------------------------------|--------------|------
MATH-733-P   | Mathematical Statistics –I  | 4(4-0)       | 80   

MATHEMATICAL STATISTICS-I


RECOMMENDED BOOKS

CONTINUOUS GROUPS

Continuous Groups; $GL(n,r), GL(n,c), SO(p,q), SP(2n)$; generalities on Continuous Groups; Groups of isometrics; Introduction to Lie groups with special emphasis on matrix Lie groups; Relationship of isometrics and Lie group; Theorem of Cartan; Correspondence of continuous groups with Lie algebras; Classification of groups of low dimensions; Homogeneous spaces and orbit types; Curvature of invariant metrics on Lie groups and homogeneous spaces.

RECOMMENDED BOOKS

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**Course Number** | **Title** | **Credit Hours** | **Marks**
--- | --- | --- | ---
MATH-735-P | Theory of Modules | 4(4-0) | 80

**THEORY OF MODULES**


**BOOKS RECOMMENDED**


4. Adamson, J. *Rings and Modules*. 

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<table>
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<tr>
<th>Course Number</th>
<th>Title</th>
<th>Credit Hours</th>
<th>Marks</th>
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<tr>
<td>MATH-736-P</td>
<td>Algebraic Topology</td>
<td>4(4-0)</td>
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</table>

**ALGEBRAIC TOPOLOGY**

Path wise connectedness; Notion of homotopy, Homotopy classes. Path homotopy. Path homotopy classes; Fundamental groups, Covering maps. Covering spaces. Lifting properties of covering spaces, Fundamental group of a circle.

**RECOMMENDED BOOKS**

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Title</th>
<th>Credit Hours</th>
<th>Marks</th>
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<tbody>
<tr>
<td>MATH-737-P</td>
<td>Advanced Topology</td>
<td>4(4-00)</td>
<td>80</td>
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</table>

**ADVANCED TOPOLOGY**

Compactness in metric spaces, Limit point, Compactness, Sequential compactness and their various characterizations, Equivalence of different notions of compactness. Connectedness, various characterizations of connectedness, Connectedness and T()spaces, Local connectedness, Path-connectedness, Components. Homotopic maps, Homotopic paths, Loop spaces, Fundamental groups, Covering spaces, the lifting theorem, Fundamental groups of the circle () etc.Chain complex, Notion of homology.

**RECOMMENDED BOOKS**

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Title</th>
<th>Credit Hours</th>
<th>Marks</th>
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<tbody>
<tr>
<td>MATH-738-P</td>
<td>Numerical Analysis-I</td>
<td>4(4-0)</td>
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**NUMERICAL ANALYSIS-I**

Introduction, Computation error and error analysis, Study of various Iterative methods to solve non-linear equations with analysis of error, Convergence and stability of Bisection, False position, Secant, Newton-Repshon and Fixed point methods, Acceleration of convergence by Aitken method, Solution of system of linear equations by LU decomposition method, Cases of failure, Iterative methods, (Jacobi, Gauss Seidel, SOR, SUR) and their convergence analysis, Ill conditioned systems and Condition number, Interpolation: Review of simple interpolation for equally spaced data, Interpolation by Gauss forward/backward methods, Bessel and Stirling method with error analysis, Lagrange Interpolation and Newton divided differences formula with error analysis, Interpolation by Spline functions (up to Cubic spline), methods of Least squares, Numerical differentiation, Numerical integration for equally spaced data (Newton cotes formula and its special cases e.g. Trapezoidal Rule and Simpson’s rules) and for unequally spaced data (using Lagrange and divided differences formula of interpolation), Gaussian quadrature using a system of orthogonal polynomials (Legendre and Laguere polynomials).

**BOOKS RECOMMENDED**


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<th>Course Number</th>
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<th>Marks</th>
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<tr>
<td>MATH-739-P</td>
<td>Linear Algebra</td>
<td>4(4-0)</td>
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**LINEAR ALGEBRA**


**BOOKS RECOMMENDED**

5. S. Lang, *Linear Algebra*, Addison-Wesley.
<table>
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<th>Course Number</th>
<th>Title</th>
<th>Credit Hours</th>
<th>Marks</th>
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<tbody>
<tr>
<td>MATH-740-P</td>
<td>Rings &amp; Fields</td>
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**RINGS AND FIELDS**

Definitions and basic concepts, homeomorphisms, homomorphism theorems. Polynomial rings. Unique factorization domain, factorization theory. Euclidean domain, arithmetic in Euclidean domains, Extension fields, Algebraic and transcendental elements, simple extension, Introduction to Galois theory.

**RECOMMENDED BOOKS**

4. Adamson, J. *Rings and Modules*. 
### Course Number | Title | Credit Hours | Marks
--- | --- | --- | ---
MATH-731-A | Fluid Mechanics- I | 4(4-0) | 80

**FLUID MECHANICS -I**

Real fluids and ideal fluids, Velocity of a fluid at a point, Streamlines and path lines, Steady ad unsteady flows, Velocity potential, Vorticity vector, Local and particle rates of change, Equation of continuity. Acceleration of a fluid, Conditions at a rigid boundary, General Analysis of fluid motion Euler’s equations of motion, Bernoulli’s equations steady motion under conservative body forces, Some potential theorems, impulsive motion. Sources, Sinks and doublets, Images in rigid infinite plane and solid spheres, Axi-symmetric flows, Stokes’s stream function. Stream function, Complex potential for two-dimensional, Irrational, Incompressible flow, Complex velocity spotential for uniform stream. Line sources and line sinks, Line doublets image systems, Miline-Thomson circle theorem, Blasius’s Theorem.

**BOOKS RECOMMENDED**

<table>
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<th>Course Number</th>
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<th>Credit Hours</th>
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<tr>
<td>MATH-732-A</td>
<td>Mathematical Physics</td>
<td>4(4-0)</td>
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**MATHEMATICAL PHYSICS**


Power Series, Solutions of Legendre’s Equation, Legendre’s polynomials Generating function; Rodrigue’s formula, Recurrsion relations. Orthogonality and normality of Legendre’s Polynomials, Legendre’s Series. Bessel’s equation, Bessel’s Functions, Generating function, Recurring relations, Orthogonality of Bassel’s function, Bessel’s series Green’s function methods applied to ODEs. Green’s function in one and two dimensions.


**BOOKS RECOMMENDED**

7. My-Tung & Debnath, Partail Differential Equations
<table>
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<tr>
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<th>Title</th>
<th>Credit Hours</th>
<th>Marks</th>
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<td>MATH-733-A</td>
<td>Mathematical Statistics -I</td>
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MATHEMATICAL STATISTICS -I


Recommended Books

SPECIAL THEORY OF RELATIVITY


BOOKS RECOMMENDED

5. J.G. Taylor, *Special Theory of Relativity*
OPERATIONS RESEARCH

LINEAR PROGRAMMING


TRANSPORTATION PROBLEMS


INTEGER PROGRAMMING

Definition and formulation- Cutting-Plane Algorithm and Branch-and Bound method, Application. The mixed Algorithm, Zero-one polynomial programming.

BOOKS RECOMMENDED

4. C. M Harvey, *Operation Research*, North Holland, New Delhi
5. Prof. Sr. Saeed Akhtar Bhatti *Operations Research: An Introduction*
QUANTUM MECHANICS


RECOMMENDED BOOKS

1. Fayyazuddin and Riazuddin, Quantum Mechanics (World Scientific 1990).
3. Liboff, R.L Introductory Quantum Mechanics, Oxford University Press.
<table>
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<th>Course Number</th>
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<th>Credit Hours</th>
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<tr>
<td>MATH-737-A</td>
<td>SoftWare Engineering</td>
<td>4(4-0)</td>
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**SOFTWARE ENGINEERING**


**RECOMMENDED BOOKS**

1. Applying UML & Patterns By Grasp
2. Practitioner’s approach towards Software Engineering by Pressman
3. Applying UML & Patterns by Craig Larman
NUMERICAL ANALYSIS-I

Introduction, Computation error and error analysis, study of various Iterative methods to solve non-linear equations with analysis of error, Convergence and stability of Bisection, False position, Secant, Newton-Repshon and Fixed point methods, Acceleration of convergence by Aitken method, solution of system of linear equations by LU decomposition method, Cases of failure, Iterative methods, (Jacobi, Gauss Seidel, SOR, SUR) and their convergence analysis, Ill conditioned systems and Condition number, Interpolation: Review of simple interpolation for equally spaced data, Interpolation by Gauss forward/backward methods, Bessel and Stirling method with error analysis, Lagrange Interpolation and Newton divided differences formula with error analysis, Interpolation by spline functions (up to cubic spline), methods of least squares, Numerical differentiation, Numerical integration for equally spaced data (Newton cotes formula and its special cases e.g. Trapezoidal Rule and Simpson’s rules) and for unequally spaced data, (using Lagrange and divided differences formula of interpolation), Gaussian quadrature using a system of orthogonal polynomials (Legendre and Laguere polynomials).

BOOKS RECOMMENDED

**Course Number** | **Title** | **Credit Hours** | **Marks**
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MATH-741- P | Measure Theory | 4(4-0) | 80

**LEBESGUE MEASURE**


**BOOKS RECOMMENDED**

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<th>Credit Hours</th>
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<td>MATH-742-P</td>
<td>Advanced Functional Analysis</td>
<td>4(4-0)</td>
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</table>
RINGS & MODULES


BOOKS RECOMMENDED

5. Lal Din Baig *Methods of Mathematical Physics 2000*.
6. Adamson, J. *Rings and Modules*. 
Course Number | Title       | Credit Hours | Marks |
-------------|-------------|--------------|-------|
MATH-744- P  | Theory of Numbers | 4(4-0)      | 80    |

THEORY OF NUMBERS


APPLICATION TO RATIONAL NUMBER THEORY

Equivalence and class number. Cyclotomic field K Fermat’s equation. Kummer’s theorem, the q equation $X^2 + 2 = Y^3$, pure cubic fields. Distribution of Primes and Riemann Zets function, the prime number theorem.

BOOKS RECOMMENDED


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<th>Credit Hours</th>
<th>Marks</th>
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<tr>
<td>MATH-745- P</td>
<td>Mathematical Statistics- II</td>
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**MATHEMATICAL STATISTICS- II**


**RECOMMENDED BOOKS**

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<tr>
<td>MATH-746-P</td>
<td>Numerical Analysis-II</td>
<td>4(4-0)</td>
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**NUMERICAL ANALYSIS-II**

Methods of least squares, Numerical Integration for equally spaced data, Newton cotnes formula and its special cases e.g. Trapezoidal Rule Simson’s Rules, Gaussian quadrature using a system of orthogonal, Polynomials (Legender and Laguere Polynomials, Numerical Differentiation, Difference Equations, Differential Equations, Euler’s Method, Improved Euler’s Methods. Mid point Formula, Heun’s Method,

**BOOKS RECOMMENDED**

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<tr>
<td>MATH-747- P</td>
<td>Theory of Optimization</td>
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**THEORY OF OPTIMIZATION**


**OPTIMIZATION BY EQUALITY CONSTRAINTS**


**RECOMMENDED BOOKS**

SPECIAL FUNCTIONS

Sturm-Liouville theory of DEs, Basic properties of a SL System, Orthogonality, Reality and uniqueness, Sturm’s comparison theorem, completeness of Eigenfunctions Via Rayleigh quotient, Bessel functions, Legendre Polynomial and their Generating functions and properties, Hermite equation and functions and their properties, Laguerre Equation and functions and their properties, chibeticf function, Hypergeomtric Differential Equations and Functions, Gamma and Beta Functions

RECOMMENDED BOOKS

   New York.
2. B. G. Korenev, Bessel Functions and their Applications
3. R. E. Attar, Special Functions and Orthogonal Polynomials
4. G. N. Watson, A Treatise on the Theory of Bessel Functions
<table>
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<th>Credit Hours</th>
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<tr>
<td>MATH-749-P</td>
<td>Project</td>
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The Project of M.Sc. Mathematics will be offered as an optional paper to not more than 50% of the class strength and only to those who obtain at least 65% marks on the basis of their performance in I & II Semesters.
<table>
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<th>Course Number</th>
<th>Title</th>
<th>Credit Hours</th>
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<tr>
<td>MATH-741-A</td>
<td>Fluid Mechanics -II</td>
<td>4(4-0)</td>
<td>80</td>
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</table>

**FLUID MECHANICS -II**


Constitutive equations; Navier-Stoke’s equations; Exact solution of Navier-Stoke’s equations; Steady unidirectional flow; Poiseuille flow; Couette flow; Unsteady unidirectional flow, Sudden motion of a plane boundary in a fluid at rest; Flow due to an oscillatory boundary; Equations of motion relative to a rotating system; Ekman flow; Dynamical similarity of turbulent motion.

**BOOKS RECOMMENDED**

**PARTIAL DIFFERENTIAL EQUATIONS**


**RECOMMENDED BOOKS**


<table>
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<tr>
<th>Course Number</th>
<th>Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>MATH-743-A</td>
<td>Theory of Elasticity</td>
<td>4(4-0)</td>
<td>80</td>
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</tbody>
</table>

**THEORY OF ELASTICITY**

Cartesian tensors, Analysis of stress and strain, Generalized Hooke’s law; crystalline structure, Point groups of crystals, Reduction in the number of elastic moduli due to crystal symmetry; Equations of equilibrium; Boundary conditions, compatibility equations; Plane stress and plane strain problems; Two dimensional problems in rectangular and polar co-ordinates; torsion of rods and beams.

**RECOMMENDED BOOKS**

ELECTROMAGNETISM

Electrostatics and the solution of electrostatics problems in vacuum and in media, Electrostatic energy, Electro currents, The magnetic field of steady currents. Magnetic properties of matter. Magnetic energy, Electromagnetic Introduction, Maxwell’s equations, Boundary Value Potential Problems in two dimensions, Electromagnetic Waves, Radiation, Motion of electric charges.

RECOMMENDED BOOKS

### Course Number | Title | Credit Hours | Marks
--- | --- | --- | ---
MATH-745- A | Mathematical Statistics- II | 4(4-0) | 80

**MATHEMATICAL STATISTICS- II**


**RECOMMENDED BOOKS**

NUMERICAL ANALYSIS-II

Methods of least squares, Numerical Integration for equally spaced data, Newton cotes formula and its special cases e.g. Trapezoidal Rule Simson’s Rules, Gaussian quadrature using a system of orthogonal, polynomials (Legender and Laguere Ploynomials, Numerical Differentiation, Difference Equations, Differential Equations, Euler’s Method, Improved Euler’s Methods. Mid point Formula, Heun’s Method,

BOOKS RECOMMENDED

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<tbody>
<tr>
<td>MATH-747-A</td>
<td>Theory of Optimization</td>
<td>4(4-0)</td>
<td>80</td>
</tr>
</tbody>
</table>

**OPTIMIZATION THEORY**


**OPTIMIZATION BY EQUALITY CONSTRAINTS**


**RECOMMENDED BOOKS**


SPECIAL FUNCTIONS

Sturm-Liouville theory of DEs, Basic properties of a SL System, Orthogonality, Reality and uniqueness, Sturm’s comparison theorem, completeness of Eigenfunctions Via Rayleigh quotient, Bessel functions, Legendre Polynomial and their Generating functions and properties, Hermite equation and functions and their properties, Laguerre Equation and functions and their properties, chibeicif function, Hypergeomtric Differential Equations and Functions, Gamma and Beta Functions

RECOMMENDED BOOKS

2. B. G. Korenev, *Bessel Functions and their Applications*
3. R. E. Attar, *Special Functions and Orthogonal Polynomials*
4. G. N. Watson, *A Treatise on the Theory of Bessel Functions*
<table>
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<tbody>
<tr>
<td>MATH-749-A</td>
<td>Project</td>
<td>4(4-0)</td>
<td>80</td>
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</table>

The Project of M.Sc. Mathematics will be offered as an optional paper to not more than 50% of the class strength and only to those who obtain at least 65% marks on the basis of their performance in I & II Semesters.
PROGRAMMING LANGUAGE C++.


**Introduction 1:** History of C++, writing C++ Program, structure, preprocessor, Header file, Main function, Increment operators+++, data types, Declaration of the variable, Initialization of the variable, Arithmetic operators, arithmetic Expression, order of precedence of operation.

**Introduction 2:** Basis input / output, cout<< object, the escape sequence, the end line, setw manipulator, Assignment operator, the cin>> operator. Compound assignment, increment and decrement operator, the comment statement, the conditional statement, loops statement, arrays, structures, functions part I and part II, pointers, inheritance, and polymorphism part I and II, Files graphics, bit wise operators.

**RECOMMENDED BOOKS**