Faculty of Natural Science and Engineering
Department of Mathematics and Informatics

Syllabus for M.Sc. in Mathematics

The Department of Mathematics and Informatics offers a program of study leading to the degree of Master of Science (M.Sc.) in Mathematics for four categories of students. The M.Sc. Final Program consists of 40 credits to be completed in three semesters (1 year).

A student who has been graduated on completion of 4 years B.Sc.(Hons.) program in Mathematics from this university, Bangladesh National University or any Public or recognized Private University of Bangladesh will be eligible directly for admission to the program.

A student who has been graduated on completion of 3 years B.Sc.(Hons.) program in Mathematics or 3 years B.Sc. (Pass) program with Mathematics as a subject from Bangladesh National University or any Public or recognized Private University of Bangladesh has to complete a Preliminary Master of Science in Mathematics non-degree program of 37 credits (minimum) in 3 semesters (1 year) for getting eligible for admission to the M.Sc. Final program.

A student who has been graduated on completion of 2 years B.Sc. (Pass) program with Mathematics as a subject from Bangladesh National University or any Public or recognized Private University of Bangladesh has to complete Graduate Diploma Program of 28 credits followed by a Preliminary Master of Science in Mathematics program as mentioned above to become eligible for admission to the M.Sc. Final program. A student on successful completion of a Graduate Diploma Program will be awarded a Graduate Diploma Certificate (GDC).

A student graduated from an overseas university will be judged for an equivalent qualification for admission into the M.Sc. Final program.

A student having a minimum of 60% class attendance will be eligible to appear in a Semester Final Examination. There will be an allocation of marks for Class Participation, Assignment, Mid-Semester Examination and Semester Final Examination. The distribution of marks in a course is as follows:

<table>
<thead>
<tr>
<th>Class Participation</th>
<th>: 10%</th>
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</thead>
<tbody>
<tr>
<td>Assignment / Tutorial Exam</td>
<td>: 10%</td>
</tr>
<tr>
<td>Presentation / Viva</td>
<td>: 10%</td>
</tr>
<tr>
<td>Mid-Semester Examination</td>
<td>: 30%</td>
</tr>
<tr>
<td>Semester Final Examination</td>
<td>: 40%</td>
</tr>
</tbody>
</table>

The grading system consists of letter grading, corresponding to Grade Point Average (GPA) as follows:

<table>
<thead>
<tr>
<th>Numerical Grade</th>
<th>Letter Grade</th>
<th>Grade Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>80% and above</td>
<td>A+</td>
<td>4.00</td>
</tr>
<tr>
<td>75% to less than 80%</td>
<td>A</td>
<td>3.75</td>
</tr>
<tr>
<td>70% to less than 75%</td>
<td>A-</td>
<td>3.50</td>
</tr>
<tr>
<td>65% to less than 70%</td>
<td>B+</td>
<td>3.25</td>
</tr>
<tr>
<td>60% to less than 65%</td>
<td>B</td>
<td>3.00</td>
</tr>
<tr>
<td>55% to less than 60%</td>
<td>B-</td>
<td>2.75</td>
</tr>
<tr>
<td>50% to less than 55%</td>
<td>C+</td>
<td>2.50</td>
</tr>
<tr>
<td>45% to less than 50%</td>
<td>C</td>
<td>2.25</td>
</tr>
<tr>
<td>40% to less than 45%</td>
<td>C-</td>
<td>2.00</td>
</tr>
<tr>
<td>36% to less than 40%</td>
<td>D</td>
<td>1.00</td>
</tr>
<tr>
<td>Below 36%</td>
<td>F</td>
<td>0.00</td>
</tr>
<tr>
<td>Incomplete</td>
<td></td>
<td>Incomplete</td>
</tr>
</tbody>
</table>

Absence from any course or the final examination will be considered incompletion of the program. The distribution of courses for the different programs in gradual order is given below along with the detailed courses.
Syllabus for Graduate Diploma Certificate in Mathematics (3 Semesters)

**First Semester**

<table>
<thead>
<tr>
<th>Course Code No.</th>
<th>Course Title</th>
<th>Hours/Week</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAI 101</td>
<td>Fundamentals of Mathematics (Algebra)</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 102</td>
<td>Fundamentals of Mathematics (Geometry)</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 103</td>
<td>Differential Calculus</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>9+0</strong></td>
<td><strong>9.0</strong></td>
</tr>
</tbody>
</table>

**Second Semester**

<table>
<thead>
<tr>
<th>Course Code No.</th>
<th>Course Title</th>
<th>Hours/Week</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAI 201</td>
<td>Integral Calculus</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 202</td>
<td>Ordinary Differential Equation</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 203</td>
<td>Vector Calculus and Mathematical Methods</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>9+0</strong></td>
<td><strong>9.0</strong></td>
</tr>
</tbody>
</table>

**Third Semester**

<table>
<thead>
<tr>
<th>Course Code No.</th>
<th>Course Title</th>
<th>Hours/Week</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAI 301</td>
<td>Introduction to Computer Language</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 302</td>
<td>Introduction to Computer Language Lab</td>
<td>0+2</td>
<td>2.0</td>
</tr>
<tr>
<td>MAI 303</td>
<td>Numerical Analysis</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 304</td>
<td>Viva Voice/Project presentation</td>
<td>0+0</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>6+2</strong></td>
<td><strong>10.0</strong></td>
</tr>
</tbody>
</table>
Detailed Syllabus

MAI 101 FUNDAMENTALS OF MATHEMATICS (ALGEBRA)
3 Hours/Week, 3 Credits

Introduction: Definitions and identities of trigonometric and hyperbolic functions with their inverses; De Moivre’s Theorem and its application. Summation of series (algebraic and trigonometric): Arithmetic and geometric series; method of difference and C+iS method (for trigonometric series). Inequalities: Inequalities involving mean; inequalities of Weierstrass, Cauchy, Tchebyshev, Holder and Minkowski. Theory of equations: Polynomials and division algorithms; fundamental theorem of algebra; multiple roots; transformation of equations; relations between roots and coefficients; Descarte’s rule of signs; symmetric functions of the roots; solutions of cubic and biquadratic equations; Sturm’s theorem.

Books Recommended:
1. Lipschutz, S: Set Theory and Related Topics
2. Bernard and Child: Higher Algebra
3. Hall and Knight: Higher Algebra
4. Shahidullah and Bhattacharjee: Higher Algebra

MAI 102 FUNDAMENTALS OF MATHEMATICS (GEOMETRY)
3 Hours/Week, 3 Credits

Two dimensional geometry: Coordinate system, straight line in a plane; distance of two lines; slope of a line; tangent and normal on a curve; pair of straight lines; basic properties of circle, parabola, ellipse and hyperbola; change of coordinates and axes; general equation of second degree; reduction of general equation of second degree to standard form and identification of conic; polar and parametric equations of conic; poles, polar and chords in terms of middle points.

Coordinates in three dimensions: Different systems of coordinates and transformations of coordinates; direction cosines; direction ratios; planes and straight lines in three dimensions; general equation of second degree in three variables, reduction to standard forms and identification of conicoids; sphere, cylinder, cone, ellipsoid, paraboloid and hyperboloid.

Books Recommended:
2. Thomas and Finney: Calculus and Analytic Geometry
3. Bell, R. J. T.: An Elementary Treatise on Coordinate Geometry of Three Dimension
4. Rahman and Bhattacharjee: Two and Three Dimensional Geometry

MAI 103 DIFFRENTIAL CALCULAS
3 Hours/Week, 3 Credits

Functions: Functions of single variable, domain and range of a function, graph of simple functions such as polynomials, exponential functions, logarithmic function and trigonometric functions, inverse function. Limit and continuity of single variable functions. Differentiation: Derivative of a function, derivative of algebraic, trigonometric and hyperbolic functions, parametric functions, implicit functions, Intermediate forms and L’Hospital rules; successive differentiations and Leibniz’s Theorem. Applications of derivatives: The significance of the first derivative; Rolle’s theorem; mean value theorem; Taylor’s theorem in different forms; Maclaurin’s series and their application for the expansion of functions; increasing and decreasing functions; concavity and point of inflection; asymptotes and symmetry; maxima and minima.

Books Recommended:
1. Thomas and Finney: Calculus and Analytic Geometry
2. Swokowski, E. W.: Calculus with Analytic Geometry
3. **Das and Mukherjee**: Differential Calculus  
4. **J. Stewart**: Calculus.

### MAI 201 INTEGRAL CALCULAS  
3 Hours/Week, 3 Credits

**Integration**: Introduction; indefinite integrals; basic integration formulas; integration by parts; products and powers of trigonometric functions; even powers of sine’s and cosines trigonometric substitutions; partial fractions; definite integrals; calculating areas as limits; the fundamental theorems of integral calculus; integration by substitution; rules for approximating definite integrals, improper integrals; reduction formulae; Gamma and Beta functions.  
**Applications of definite integrals**: Area between two curves; calculating volumes by slicing; volumes modeled with shells and washers; length of a plane curve; area of a surface of revolution; average value of a function.

**Books Recommended:**
1. **Thomas and Finney**: Calculus and Analytic Geometry  
2. **Swokowski, E. W.**: Calculus with Analytic Geometry  
3. **Das and Mukherjee**: Integral Calculus

### MAI 202 ORDINARY DIFFRENTIAL EQUATIONS  
3 Hours/Week, 3 Credits

**Introduction** to differential equations. **Ordinary differential equations and their solutions**: Ordinary differential equations of first order and first degree; ordinary differential equations of 1st order but of higher degree; initial value problem; orthogonal trajectories; general solution of linearordinary differential equations (homogeneous and non-homogeneous) with constant coefficients; methods of undetermined coefficients and variation of parameters; reduction of order; solution in series; simple cases of non-linear differential equations; system of linear ordinary differential equations.

**Books Recommended:**
1. **Ayres, F.**: Differential Equations  
2. **Ross, L.**: Introduction to Differential Equations  
3. **Ch. V. Ramana Marty & N.C. Srinivas**: Applied Mathematics

### MAI 203 VECTOR CALCULUS AND MATHEMATICAL METHODS  
3 Hours/Week, 3 Credits


**Books Recommended:**
1. **Stephenson**: Mathematical Methods  
2. **Ross, S. L.**: Introduction to Differential Equations  
3. **Spiegel, M. R.**: Laplace Transform  
4. **Spiegel, M.R.**: Vector Analysis  
5. **M. Abdur Rahman**: Mathematical Methods; Vol: 1&2
MAI 301 INTRODUCTION TO COMPUTER LANGUAGE
3 Hours/Week, 3 Credits

Programming Language: Basic concepts, overview of programming languages, problem solving techniques and data flow diagram. C-Language: preliminaries, program constructs, variables and data types in C, input and output, character and formatted I/O, arithmetic expressions and assignment statements, loops and nested loops, decision making, arrays, functions, arguments and local variables, calling functions and arrays, recursion and recursive functions, structures with in structure, files, file functions for sequential and random I/O. Pointers: pointers and structures, pointer and functions, pointer and arrays, operation and pointer, pointer and memory addresses.

Operations on Bits: Bit operation, bit field, advanced features, standard and library.

Books Recommended:
1. Kernigh & Ritchie: The C Programming Language
2. H. Schildt: Teach Yourself C
3. Schaum's outline Series: Programming with C
4. H. Schildt: The Complete Reference, Turbo C/C++

MAI 302 INTRODUCTION TO COMPUTER LANGUAGE LAB
2 Hours/Week, 2 Credits

Syllabus will be designed by the course teacher on the basis of MIS 311.

MAI 303 NUMERICAL ANALYSIS
3 Hours/Week, 3 Credits

Errors in numerical calculations: Errors definitions, sources, examples; propagation error; a general error formula. Root finding: The bisection method; the iteration method; the method of false position; Newton-Raphson method. Methods of interpolation theory: Polynomial interpolation; error in polynomial interpolation; interpolation using Newton’s forward and backward formulas and Newton’s divided difference formula and central difference formula; Starling’s interpolating polynomial; Lagrange’s interpolating polynomial; idea of extrapolation. Numerical integration: Trapezoidal method; Simpson’s method; Weddle’s method; Romberg’s method; error analysis. Interpolation: Quadratic and cubic spline interpolation methods. Solutions of systems of linear equations: Gaussian elimination with and without pivoting; iteration method; solution of tri-diagonal system of equations. Numerical solution of ordinary differential equation (IVP): Euler’s method (including modified form); Runge-Kutta method; predictor and corrector method. Boundary value problem: explicit and implicit finite difference method for BVP involving ODE; explicit finite difference method for BVP involving PDE (elliptic, parabolic and hyperbolic).

Books Recommended:
1. Hilderman, F. B.: Introduction to Numerical Analysis
3. Gerald and Wheatley: Applied Numerical Analysis
6. Dr. A. Singera Veld: Numerical Methods

MAI 304 VIVA VOCI/ PROJECT PRESENTATION
2 Credits
Faculty of Natural Science and Engineering  
Department of Mathematics and Informatics  

Syllabus for Preliminary Master of Science in Mathematics (3 Semesters)

**First Semester**

<table>
<thead>
<tr>
<th>Course Code No.</th>
<th>Course Title</th>
<th>Hours/Week</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAI 511</td>
<td>Set Theory and Elementary Logic</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 512</td>
<td>Linear Algebra</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 513</td>
<td>Real Analysis</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 514</td>
<td>Linear Programming</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>12+0</strong></td>
<td><strong>12.0</strong></td>
</tr>
</tbody>
</table>

**Second Semester**

<table>
<thead>
<tr>
<th>Course Code No.</th>
<th>Course Title</th>
<th>Hours/Week</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAI 521</td>
<td>Complex Analysis</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 522</td>
<td>Theory of Numbers</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 523</td>
<td>Hydrodynamics</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 524</td>
<td>Fundamental of Computer Techniques</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>12+0</strong></td>
<td><strong>12.0</strong></td>
</tr>
</tbody>
</table>

**Third Semester**

<table>
<thead>
<tr>
<th>Course Code No.</th>
<th>Course Title</th>
<th>Hours/Week</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAI 531</td>
<td>General Topology</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 532</td>
<td>Tensor Analysis</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 533</td>
<td>Object Oriented Programming</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 534</td>
<td>Object Oriented Programming Lab</td>
<td>0+2</td>
<td>2.0</td>
</tr>
<tr>
<td>MAI 535</td>
<td>Dynamics</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 536</td>
<td>Computational Biology</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 537</td>
<td>Viva Voce/Project Presentation</td>
<td>0+0</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>15+2</strong></td>
<td><strong>19.0</strong></td>
</tr>
</tbody>
</table>

* A student has to complete a minimum 13.0 credits. Course MAI-537 is compulsory. Courses will be selected by the department.

**Total Credits for the program:** $12.0 + 12.0 + 13.0 = 37.0$
Detailed Syllabus

MAI 511 SET THEORY AND ELEMENTARY LOGIC
3 Hours/Week, 3 Credits

Sets: Elementary idea of set; subsets; power set of a set; product set; basic set operations and related theorems on sets; Venn diagrams; countable and uncountable sets; cardinality of a set. Real number system: Set of natural numbers; rational numbers; irrational numbers and real numbers along with their geometrical representation; idea of open and closed interval; product set of real numbers and their geometric representation; idea of absolute value of real number; axioms of real number system and their applications in solving algebraic equations. Relations and Functions: Binary relations; reflexive, symmetric anti-symmetric and transitive relations; pictorial representations of relations; properties of relation; variable of a set; functions of a variable; domain and range of a function; polynomial; graph of single polynomial functions; exponential, logarithmic, trigonometric functions and their graphs; algebra of functions; inverse of functions and its graph; vertical line test for a function and test for symmetry of functions; test for continuity of a function from its graph. Logic: Introduction to logic; elements of logic; conditional propositions and logical equivalence; quantifiers; method of proofs; mathematical induction; recursion and iteration.

Books Recommended:
1. Seymour Lipschutz: Set Theory
2. R. David Gustafson and Peter D. Frisk: Functions and Graphs

MAI 512 LINEAR ALGEBRA
3 Hours/Week, 3 Credits

Introduction to matrices; addition and multiplication of matrices; determinant of matrix; types of matrices; adjoint and inverse of a matrix; elementary row operations and echelon forms of matrix; rank of a matrix; row rank and column rank of a matrix and their equivalence; use of rank and echelon form in solving system of homogeneous and non-homogeneous equations. Vector space and subspace over real numbers, direct sum; linear combination; linear dependence and independence of vectors; basis and dimension of vector space; quotient space; isomorphism theorems. Linear transformations; kernel, rank and nullity; matrix representation; change of basis; eigenvalues and eigenvectors; characteristic equations; Cayley-Hamilton theorem; diagonalization of matrices; similar matrices; canonical forms; orthogonal and Hermitian matrices. Inner product: inner product space, orthogonal vectors and orthonormal basis, Gram-Schmidt orthogonalization process, Bilinear and quadratic forms.

Books Recommended:
3. Kolman, B.: Elementary Linear Algebra
4. Nering, E. D.: Linear Algebra and Matrix Theory
5. Lipschutz, S.: Linear Algebra
6. Otto Bretchje: Liner Algebra
MAI 513 REAL ANALYSIS
3 Hours/Week, 3 Credits

Real number system: Bounded sets of real numbers; supremum and infimum; the completeness axiom and Dedekind’s axiom; neighborhoods; open and closed sets of real numbers; limit/cluster points of a set of real numbers; Media State Bolzano-Weierstrass theorem; derived set and closure of a set. Sequence of real numbers: Definition of a sequence; convergence of a sequence; subsequence; monotonic sequence; bounded sequence; Cauchy sequence; Cauchy criteria for convergence of sequences. Infinite series: Concept of sum and convergence; series of positive terms; alternating series; absolute and conditional convergence; various tests for convergence. Limit, continuity and differentiability of functions: Limit and continuity of functions with their properties; uniform continuity; Heine-Borel theorem; differentiability of functions; Rolle’s theorem; mean value theorem; Darboux theorem; intermediate value theorem for derivatives; Taylor’s theorem with remainder in Lagrange’s and Cauchy’s forms; Maclaurin’s series; expansions of functions. Power series: Interval and radius of convergence; differentiation and integration of power series; identity theorem; Abel's continuity theorem. Riemann integrals: Riemann sum and Riemann integral; Darboux sums and Darboux integrals; Darboux integrability and Riemann integrability; properties of integrals; fundamental theorem of integral calculus.

Books Recommended:
1. *Rudin, W.: Principle of mathematical analysis*
2. *Apostol, I.: Mathematical Analysis*
3. *Bartle: Real Analysis*
5. *Burkill, J. G.: A First Course in Mathematical Analysis*

MAI 514 LINEAR PROGRAMMING
3 Hours/Week, 3 Credits

Linear programming: Linear programs; convex set; graphical solution of systems of linear inequalities and linear program; solution of linear program by simplex method; algebraic basis and computational set up; duality problem-duality theorem; transportation set problems; assignment problem and simple applications; connection between linear programming and two-person zero-sum matrix game; simple inventory problems.

Books Recommended:
1. *Haldey, G.: Linear Programming*
2. *Gass, S.I.: Mathematical Programming*
3. *Luenberger: Linear and Nonlinear Programming*

MAI 521 COMPLEX ANALYSIS
3 Hours/Week, 3 Credits

Complex variables: Geometry of the complex plane; elementary functions of a complex variable (including the general power and the logarithm). Limit, continuity and differentiability of functions of a complex variable; analytic functions and their properties; harmonic functions; meromorphic function and entire function. Complex integrals: Line integrals over rectifiable curves; Cauchy’s theorem for simple contours; Cauchy’s integral formula; theorems of Liouville and Morera; fundamental theorem of algebra. Zeros, singularities, poles and residues; Taylor’s and Laurent’s series; expansion of functions; Cauchy’s residue theorem; Rouche’s theorem; the maximum modulus principle; evaluation of real integrals by contour integrations. Conformal mappings, bilinear transformations and their properties.

Books Recommended:
1. *Churchill and Brown: Complex variables and Applications*
2. *Stewart and Tall: Complex Analysis*
3. *Spiegel, M. R.: Complex Variable*
MAI 522 THEORY OF NUMBERS
3 Hours/Week, 3 Credits

Divisibility and greatest common divisors; arithmetic in Z; prime numbers and perfect numbers; fundamental theorem of arithmetic and its consequences; division algorithm; congruence; least residue theorem; Fermat’s theorem, Euler’s theorem and Wilson's theorem; solutions of congruence; Lagrange’s theorem of congruence; Chinese remainder theorem; arithmetic functions and their properties; multiplicative functions; Zeta function and its relation with arithmetic functions; quadratic residues and non-residues; law of quadratic reciprocity; Legendre symbol; some Diophantine equations and their solutions; representation of integers by sum of two squares or four sum squares; solution of the equation $z^2 = x^2 + y^2$; Selberg’s proof of the prime number theorems.

Books Recommended:
1. Apostol: Theory of Numbers
3. Niven and Zucherman: Theory of Numbers
6. S.G. Telang: Theory of Numbers

MAI 523 HYDRODYNAMICS
3 Hours/Week, 3 Credits

Introductory motion: Physical dimension; stream lines and path lines; hydrodynamic pressure; Bernoulli’s theorem; adiabatic expansion. Equation of motion: Equation of continuity; equation of motion of inviscid liquid and Bernoulli’s equation; steady motion and conservative forces; circulation and Kelvin’s theorem; vorticity; irrotational motion and velocity potential; the energy equation; kinetic energy and Kelvin’s minimum energy theorem. Two dimensional motions: Rate of change of vorticity; stream function and pressure equation; streaming motions; complex potential and complex velocity; stagnation points; circle theorem; motion past a cylinder; Joukowski transformation; Blasius theorem, source and sink: Doublets; complex potentials due to sources sinks and doublets ; source and sink of equal strength; source and sink in a stream; method of images calculation of pressure on boundary walls due to sources ;

Books Recommended:
1. Milne-Thompson, L. M.: Theoretical Hydrodynamics
2. Lamb, H.: Hydrodynamics
3. Ramsey: Hydrodynamics
4. Shanti Swarup: Hydrodynamics

MAI 524 FUNDAMENTAL OF COMPUTER TECHNIQUE
3 Hours/Week, 3 Credits


4. Fundamental of Computer
MAI 531 GENERAL TOPOLOGY
3 Hours/Week, 3 Credits

Topology and topological space: open sets and closed sets; closure of a set; interior, exterior and boundary; neighborhoods and neighborhoods systems; weak and strong topology; topology of the real line and plane; cofinite and cocountable topology; subspaces; relative topology; bases and subbases for a topology; continuity and topological equivalence; homeomorphic spaces. Metric and normed spaces: Metric topologies; properties of metric spaces; metrizable space; Hilbert space; convergence and continuity in metric space; normed spaces. Countability: First countable spaces; second countable spaces and related theorems. Compactness: Covers; compact sets; subset of a compact space; finite intersection property; Bolzano-Weierstrass theorem; locally compact spaces. Connectedness: Separated sets; connected sets; connected spaces; components; locally connected spaces and simply connected spaces. Separation axioms: T1-spaces; Hausdorff spaces; regular spaces; normal spaces; completely normal spaces and completely regular spaces.

Books Recommended:
1. Simmons, G.F.: Introduction to Topology and Modern Analysis
2. Gal, S.: Point Set Topology
3. Lipschutz, S.: General Topology
5. Hockling and Young: Topology

MAI 532 TENSOR ANALYSIS
3 Hours/Week, 3 Credits

N dimensional spaces, Summation convention, Transformation of coordinates; covariant and contravariant tensor; mixed tensors, conjugate tensor; associated tensor; Algebra of tensors, Relative tensors, Metric tensors, fundamental operations on tensors; Christoffel symbols and their transformations; covariant differentiation; parallelism and geodesics; Riemann-Christoffel tensor; curvature tensor; Ricci tensor and Bianchi identity and Einstein tensor.

Books Recommended:
2. Lass, H.: Vector and Tensor Analysis
3. Spain, B.: Tensor Calculus

MAI 533 OBJECT ORIENTAL PROGRAMMING
3 Hours/Week, 3 Credits

MAI 534 OBJECT ORIENTAL PROGRAMMING LAB
2 Hours/Week, 2 Credits

Object-Oriented Programming: Classes and objects, Constructors and destructor, Encapsulation of class
members and methods, Manipulating objects. Dynamic Memory Allocation: Pointers to objects, Pointers and
arrays, Call-by-reference and call-by-value. Concept of Inheritance, Interface and Polymorphism: Direct and
indirect inheritance, Private and protected members of inherited class, Constructors and destructors under
inheritance, Polymorphism, Abstract base classes. Exceptions: Error handing in program, Creating own
exception. Handling Files: Input/Output streams, Processing files, Random access files. Thread Programming:
Introduction to threads, Using threads to solve multi-tasking problems, Thread synchronization. Client-Server
programming: Applet and Servlets, Introduction to JSP, Socket programming. GUI: Basic user interface design
using Java swing.

Understanding Java Enterprise Level Works.

MAI 535 DYNAMICS
3 Hours/Week, 3 Credits

Kinematics of particles: Mechanical vibrations: Simple harmonic motion; application of the principle of
conservation of energy; motion under a central force and conservative central force; principle of impulse and
momentum; impulsive motion. System of particles: Applications of Newton’s laws to the motion of a system of
particles; effective forces; linear and angular momentum of a system of particles; conservation of momentum
and energy for a system of particles; work energy principles. Kinematics of rigid bodies: Translation, rotation,
velocity, acceleration and plane motion of a particle relative to a rotating frame; Corilis acceleration. Plane
motion of rigid bodies: Equations of motion for a rigid body; motion of a rigid body in two dimensions;
Euler’s equation of motion of a rigid body about a fixed point.

Books Recommended:
1. Synge and Griffiths: Principle of Mechanics
5. Khanna, M.L: Dynamics
6. Chorlton, F.: Text Book of Dynamics

MAI 536 COMPUTATIONAL BIOLOGY
3 Hours/Week, 3 Credits

Understand basic concepts in bioinformatics; Understand bioinformatics is an interdisciplinary field that needs
computer science, biology and other majors to collaborate; Receive an introduction and historical perspective to
the field of bioinformatics; Learn the key methods and tools used in bioinformatics (a) Learn to use
bioinformatics resources, including software, database search engines, and other Internet tools; (b) Learn to use
data visualization tools in bioinformatics research; (c) Learn key computational procedures and algorithms to
analyze structures and functions of biological systems; (d) Learn basic methods for digitizing, storing,
processing and displaying information related to informatics applications. Be prepared to use bioinformatics in
your own work. Build a solid foundation and ability to collaborate with others to solve bioinformatics problems.

Books Recommended:
1. Durbin et al: Biological Sequence Analysis
3. Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison: Biological Sequence Analysis
5. John A. Jacquez: Compartmental Analysis in Biology and Medicine, Second Edition

MAI 537 VIVA VOCE/PROJECT PRESENTATION
2 Credits
Faculty of Natural Science and Engineering  
Department of Mathematics and Informatics  

Syllabus for Final Master of Science in Mathematics (3 Semesters)  

**First Semester**  

<table>
<thead>
<tr>
<th>Course Code No.</th>
<th>Course Title</th>
<th>Hours/Week</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAI 611</td>
<td>Theory of Groups</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 612</td>
<td>Functional Analysis</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 613</td>
<td>Analytical Dynamics</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 614</td>
<td>Fluid Dynamics</td>
<td>3+0</td>
<td>3.0</td>
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<td><strong>Total</strong></td>
<td><strong>12+0</strong></td>
<td><strong>12.0</strong></td>
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**Second Semester**  

<table>
<thead>
<tr>
<th>Course Code No.</th>
<th>Course Title</th>
<th>Hours/Week</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>MAI 621</td>
<td>Theory of Ring and Modules</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 622</td>
<td>Differential and Integral Equations</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 623</td>
<td>Discrete Mathematics</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 624</td>
<td>Operation Research</td>
<td>3+0</td>
<td>3.0</td>
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<td><strong>12+0</strong></td>
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**Third Semester**  

<table>
<thead>
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<th>Course Code No.</th>
<th>Course Title</th>
<th>Hours/Week</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>MAI 631</td>
<td>Lattice Theory and Boolean Algebra</td>
<td>4+0</td>
<td>4.0</td>
</tr>
<tr>
<td>MAI 632</td>
<td>Quantum Mechanics</td>
<td>4+0</td>
<td>4.0</td>
</tr>
<tr>
<td>MAI 633</td>
<td>Theory of Relativity</td>
<td>4+0</td>
<td>4.0</td>
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<tr>
<td>MAI 634</td>
<td>Differential Geometry</td>
<td>4+0</td>
<td>4.0</td>
</tr>
<tr>
<td>MAI 635</td>
<td>Metrology and Physical Oceanography</td>
<td>4+0</td>
<td>4.0</td>
</tr>
<tr>
<td>MAI 636</td>
<td>Computer Network</td>
<td>3+0</td>
<td>3.0</td>
</tr>
<tr>
<td>MAI 637</td>
<td>Computer Networks Lab</td>
<td>0+1</td>
<td>1.0</td>
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<tr>
<td>MAI 638</td>
<td>Project and Presentation</td>
<td>0+0</td>
<td>2.0</td>
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<tr>
<td>MAI 639</td>
<td>Viva Voce</td>
<td>0+0</td>
<td>2.0</td>
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<td><strong>Total</strong></td>
<td><strong>23+1</strong></td>
<td><strong>28.0</strong></td>
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* A student has to complete a minimum of 16.0 credits. Course MAT 638 & MAT 639 are compulsory. Courses will be selected by the department.

Total Credits: 12.0 + 12.0 + 16.0 = 40.0
Detailed Syllabus

MAI 611 THEORY OF GROUPS
3 Hours/Week, 3 Credits

The class equation of a group; p-group and related theorems; Cauchy’s theorem; commutator subgroup; characteristic subgroup; maximal subgroup. Group action on a set; doublecosets; Sylow’s theorems with applications; groups of order pq; classification of groups of small orders (up to 15). Normal/ subnormal series; composition series; Jordan-Hölder theorem; Zassenhans’s Butterfly Lemma. Solvable groups and nilpotent groups with related theorems. Direct products of groups with application. Group extension; splitting extension of groups; non-abelian group of order p³. Representation of groups; generalization of Cayley’s theorem; permutational and matrix representation of finite groups; Maschke’s theorem; Schur’s lemma; Galois Theory.

Books Recommended:
4. Martin Burrow: Representation Theory of Finite Groups

MAI 612 FUNCTIONAL ANALYSIS
3 Hours/Week, 3 Credits


Books Recommended
1. A.E. Taylor: Introduction to Functional Analysis
2. L.J. Maddox: Elements of Functional Analysis
3. H.G. Heuser: Functional Analysis
4. W. Rudin: Functional Analysis
5. C.L. Devito: Functional Analysis & Linear Operator Theory

MAI 613 ANALYTICAL DYNAMICS
3 Hours/Week, 3 Credits

Kinematics of particles: Mechanical vibrations: Simple harmonic motion; application of the principle of conservation of energy; motion under a central force and conservative central force; principle of impulse and momentum; impulsive motion. System of particles: Applications of Newton’s laws to the motion of a system of particles; effective forces; linear and angular momentum of a system of particles; conservation of momentum and energy for a system of particles; work energy principles. Kinematics of rigid bodies: Translation, rotation, velocity, acceleration and plane motion of a particle relative to a rotating frame; Coriolis acceleration. Plane motion of rigid bodies: Equations of motion for a rigid body; motion of a rigid body in two dimensions; Euler’s equation of motion of a rigid body about a fixed point.

Books Recommended:

1. H. Schlichting: Boundary Layer Theory
2. J. N. Hunt: Incompressible Fluid Dynamics
3. L. Rosenhead: Laminar Boundary Layers
5. L.M. Milne-Thomson: Theoretical Hydrodynamics
6. F. Chorlton: A Text Book of Fluid Dynamics
7. G.K. Batchelor: The Theory of Homogeneous Turbulence
8. D. Meksyn: New Methods in Laminar Boundary Layer Theory
10. M. D. Rai Singhania: Fluid Dynamics

MAI 621 THEORY OF RINGS AND MODULES
3 Hours/Week, 3 Credits

Embedding of Rings, local rings, Artinian&Noetherian rings, Zorn’s Lemma. Principal ideal domain (PID), unique factorization domain (UFD), Euclidean domains, polynomial rings over UFD, Divisibility in integral domain, Factorization theory for polynomial domains. Homomorphism of rings, isomorphism theorems of rings, quotient rings, rings of fractions & embedding theorems. Sum & direct sum of ideals, maximal & prime ideals, nilpotent ideals. Integral domain and field with related theorems; characteristic of a field. Module and Module homeomorphisms, Sequences and exact Sequences; Projection and injective modules.

Books Recommended:

1. John R. Durbin: Modern Algebra an introduction
2. I.N. Herstein: Topics in Algebra
3. Dean, R.A.: Elements of Abstract Algebra
5. D.G. Northcott: Ideal Theory

MAI 622 DIFFERENTIAL AND INTEGRAL EQUATIONS
3 Hours/Week, 3 Credits

General concepts: Linearity, well-posedness, initial and boundary value problems. Diffusion: The heat equation, existence and uniqueness of solutions, fundamental solutions, symmetric random walks, and Brownian
motion. The Laplace/Poisson Equation: Properties of harmonic functions; Representation formulae for solutions in terms of potential functions, including both single and double layer potentials. First order equations and scalar conservation laws: Traffic dynamics, the method of characteristics, integral (weak) solutions, the formation of shocks. Waves and Vibrations: Fundamentals of wave propagation; the classical formulae of d’Alembert, Kircho, and Poisson. Nonlinear wave equations: the KdV and non-linear Schrödinger equations, solutions, applications to water waves and nonlinear optics. Weak solutions and regularity theory: An introduction to distributions, Sobolev spaces, and weak solutions and regularity theory for elliptic equations.

Books recommended:

2. S. Salsa: Partial Differential Equations in Action: From Modeling to Theory”.

MAI 623 DISCRETE MATHEMATICS
3 Hours/Week, 3 Credits

Number systems: Numbers with different bases; their conversions and arithmetic operations; normalized scientific notation. Application of Logic: Logic gates; minimization of Boolean expressions; Karnaugh maps; Karnaugh map algorithm. Graphs: Introduction; the bridges of Königsberg; representing graphs and graph isomorphism; connected graph; planar graph; path and circuit; shortest path algorithm; Eulerian path; Euler’s theorem; graph coloring. Application of graphs: Trees; tree traversal; trees and sorting; cryptology coding; decoding; encoding. Huffman code; error correcting codes; Hamming code; spanning tree; minimum spanning trees; Kruskal’s algorithm. Modeling computation: Languages and grammars; finite state machine; language of finite state machine; accepted and non-accepted finite state machine; turing machine.

Books Recommended:

3. Cameron, P. J. and J. H. Van Kint: Graph Theory, Coding Theory and Block Designs C.U.P 197

MAI 624 OPERATION RESEARCH
3 Hours/Week, 3 Credits


Books recommended:

MAI 631 LATTICE THEORY AND BOOLEAN ALGEBRA
4 Hours/Week, 4 Credits

Ordered sets: Ordered sets; diagrams; constructing and deconstructing ordered sets; down-sets and up-sets; order preserving map. Lattices and complete lattices: Lattices as ordered sets; lattices as an algebra; sublattices and convex sublattice of a lattice; product lattice; ideals and filters; prime ideals and maximal ideals; Zorn’s Lemma; complete lattice; chain conditions and completeness; join irreducible elements. Modular, distributive and Boolean lattices: Modular and distributive lattices and its characterizations; ideals; prime ideals and maximal ideals for modular and distributive lattices; Stone’s separation theorem; Boolean lattice and Boolean algebra. Congruences and lattice homomorphism: Introducing congruence; congruences and diagrams; the congruences lattice; factor lattice; lattice homomorphism and related theorems. Representation: Finite Boolean algebras and power set algebras; finite distributive lattice and finite ordered sets in partnership; Stone’s representation theorem for Boolean algebras; Priestley’s representation theorem for distributive lattices; distributive lattices and Priestley spaces in partnership.

Books Recommended:


MAI 632 QUANTUM MECHENICS
4 Hours/Week, 4 Credits

Physical basis of quantum mechanics: Blackbody Radiation, Planck’s law. Einstein’s photon theory. Compton effect, Principel of Uncertainty, Rutherford atom model & Bohr’s theory, de-Broglie waves & wave packets. waves Mechanical Concepts: Schrödinger wave equation, physical interpretation & boundary Conditions of wave function. Expectation value & Ehven-feosts theorem, finite potential step, one dimensional square well potential energy eigenvalues & energy eigenfunctions, Box normalization, Closure property, linear harmonic oscillator, Spherically symmetry potential & three dimensional square well potential.

Books Recommended:

2. Dirac, P.M., Quantum Mechanics
3. Sehig L.I., Quantum Mechanics
4. Powell & Crosemann Quantum Mechanics

MAI 633 THEORY OF RELATIVITY
4 Hours/Week, 4 Credits

Introduction, Galilean transformations, Michelson-Morkey experiment, the postulates of the theory of special relativity, the relativity of simultaneity, derivation of the Lorentz transformation equations, the transformation properties of velocity, acceleration, momentum, energy mass and force, the equivalence of mass and energy. Minkowski space-time ‘continuum’, relativity of electromagnetism, four dimensional expression of Maxwell’s equations, the clock paradox. Introduction, Principle of equivalence, Principle of covariance, Einstein’s field equation, Einstein’s law of gravitation, Schwarzachild’s solution of Einstein’s equation, the ideal of unified field theory. The three crucial tests of the general theory of relativity, the black hole concept. The cosmological principle, The Robertson-walker metric, the Friedman models, the state cosmology, the standard model cosmology.

Books recommended:

1. Moshe Carmeli: Classical fields: General Relativity and Gauge Theory
2. Sean M. Carroll: Lecture notes on General Relativity
3. Robert resnick: Introduction to Special relativity
4. J. V. Narlikar: General relativity and cosmology
5. Tolman: Relativity, thermodynamics & cosmology
6. Satyaprakash: Relativistic mechanics
MAI 634 DIFFERENTIAL GEOMETRY
4 Hours/Week, 4 Credits

Curves in space: Concepts of space curves and their applications, tangent, normal and bi-normal, osculating plane, rectifying plane and normal plane, curvature and torsion, Serret-Frenet formulae, helices, evolutes and involutes. Elementary theory of surfaces: First fundamental form, second fundamental form, Euler’s theorem, Gaussian curvature, mean curvature, the equation of Gauss–Weingarten, the theorem of Gauss and equation of Codazzi, developable surface, minimal surface, ruled surface. Mapping of surfaces: Conformal mapping, geodesic mapping, isometric mapping.

Books Recommended:

1. T. J. Willmores: Differential Geometry
2. W. Klingenberg : A course in Differential Geometry
3. C. E. Weatherburn : Differential Geometry in three dimension

MAI 635 METROLOGY AND PHYSICAL OCEANOGRAPHY
4 Hours/Week, 4 Credits


Response of upper ocean to winds: Ekman layer at the sea surface, Ekman number, Influence of stability in Ekman layer, Ekman mass transport.

Field works:

Books recommended:


MAI 636 COMPUTER NETWORKS
3 Hours/Week, 3 Credits


**MAI 637 COMPUTER NETWORKS LAB**
**1 Hour/Week, 1 Credit**


**MAI 638 PROJECT AND PRESENTATION**
**2 Credits**

**MAI 639 VIVA VOCE**
**2 Credits**