M.Sc.  MATHEMATICS

RULES AND REGULATIONS
SCHEME OF INSTRUCTION AND SYLLABI
of
P.G. Programs
### M.Sc. APPLIED MATHEMATICS

#### COURSE STRUCTURE

**I Year I Semester**

<table>
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<th>S. No.</th>
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Total number of credits for the course is 100

## LIST OF ELECTIVES

**Elective - I**
- MA 5161 Methods of Applied Mathematics
- MA 5162 Mathematical Modelling
- MA 5261 Symbolic Computing

**Elective - II**
- MA 6111 Multivariate Analysis
- MA 6112 Wavelet Analysis
- MA 6113 Finite Volume Methods

**Elective - III and IV**
- MA 6161 Measure and Integration
- MA 6162 Fuzzy Mathematics and Applications
- MA 6163 Computational Fluid Dynamics
- MA 6164 Bio Fluid Mechanics
- MA 6262 Multi-objective Programming
- MA 6263 Financial Mathematics
Syllabus

M.Sc. APPLIED MATHEMATICS

MA5101
REAL ANALYSIS
(3-1-0)4

Basic Topology - metric spaces - compact sets - perfect sets - connected sets - Riemann Stieltje's integral
- Improper integrals - Uniform convergence of series - Power series - Fourier series.

Reading:

MA5102
DISCRETE MATHEMATICS
(3-1-0)4

Sets and propositions - Permutations, combinations, numeric functions, generating functions - Recurrence
relations and recursive algorithms - Relations and functions - Boolean algebra - Graphs and planar graphs,
multigraphs and weighted graphs, Trees and cut-sets.

Reading:
3. Tremblay and Manohar, *Discrete Mathematical Structures with Applications to Computer Science*,

MA5103
LINEAR ALGEBRA
(3-1-0)4

Systems of linear equations - Moore-Penrose Generalised inverse - Vector spaces - subspaces -
characteristic values and vectors - Cayley Hamilton theorem - annihilating polynomial - invariant subspaces-
Simultaneous triangularisation - simultaneous diagonalisation - Jordan form - inner product spaces - unitary
and normal operators - bilinear forms.

Reading:
Delhi, 1991.

MA5104
ORDINARY DIFFERENTIAL EQUATIONS
(3-1-0)4

First order and higher order differential equations - method of variation of parameters - linear equations with
variable coefficients - Legendre and Bessel equations - systems of differential equations - non-homogeneous
linear systems - successive approximation - Picard's theorem - nonuniqueness of solutions - continuous
dependence on initial conditions.

Reading:
2006.
Press, New Delhi, 1981.

MA5105
PROGRAMMING AND DATA STRUCTURES
(3-1-0)4

C-language : operators and expressions, control structures, functions, header files, scope rules, pointers
and arrays, address arithmetic, command line arguments, structures - Stacks and Recursion - Lists -
Searching and Sorting.
Reading:

**MA5106**
**NUMERICAL ANALYSIS**


Reading:

**MA5107**
**PROGRAMMING LABORATORY**

Simple programs in C language using pointers, String manipulation, File processing, Program to implement Stacks and Queues, conversion of infix to postfix expression, Programs on Recursion, Programs for Searching, Programs for sorting.

**MA5151**
**INTEGRAL AND DISCRETE TRANSFORMS**


Reading:

**MA5152**
**PROBABILITY AND STATISTICS**

Probability - Bayes' Theorem - probability distributions with discrete and continuous random variables - joint probability mass function - testing of hypothesis for large and small samples - chi-square test linear correlation and linear regression - rank correlation - correlation of bivariate frequency distribution.

Reading:

**MA5153**
**PARTIAL DIFFERENTIAL EQUATIONS**

Formulation - linear and quasi-linear first order partial differential equations - Paffian equation - Equations of higher order: Method of solution for the case of constant coefficients - method of solution by separation of variables: Laplace's equation, Wave equation, Diffusion equation.

Reading:

**MA5154**
**TOPOLOGY**

### Reading


#### MA5155  
**MECHANICS**  
(3-1-0)4

- Systems of particles: Linear and Angular momentum and rate of change of angular momentum of a system of particles
- Rigid body: Moments of inertia; Kinetic energy and angular momentum
- Euler's motion under no forces; Eulerian angles; Lagrange's and Hamilton's equations of motion
- Elementary problems: motion of a top.

#### Reading


#### MA5161  
**METHODS OF APPLIED MATHEMATICS**  
(3-0-0)3

- Tensor Analysis: covariant and contravariant vectors, contraction, second and higher order tensors, quotient law, covariant and intrinsic derivatives, geodesics
- Integral equations: connection with differential equations, integral equations of the convolution type
- Green's functions: Non homogeneous boundary value problems, one dimensional Green's function.

#### Reading


#### MA5162  
**MATHEMATICAL MODELLING**  
(3-0-0)3

- Introduction - Microbial population models
- Single species and two species population models
- Multispecies population models
- Optimal exploitation models
- Epidemic models
- Models in genetics
- Mathematical models in pharmacokinetics
- Models for blood flows.

#### Reading


#### MA5261  
**SYMBOLIC COMPUTING**  
(3-0-0)3

- Introduction to Mathematica, Programming in Mathematica
- Numeric calculation using Mathematica
- Symbolic computing with Mathematica
- Programming in MATLAB, Built-in functions
- Application to Linear algebra, curve fitting and interpolation, numerical integration and solving Ordinary differential equations.

#### Reading


#### MA5156  
**COMPUTING LABORATORY**  
(0-0-3)2

- Programs for solution of quadratic equation
- Solution of algebraic and transcendental equations
- Gauss-Seidel method
- Inverse of a matrix
- Gaussian elimination
- Numerical integration
- Euler's and modified Euler's methods
- Runge-Kutta methods
- Tridiagonal system by Thomas algorithm.

#### MA6101  
**MATHEMATICAL PROGRAMMING**  
(3-1-0)4

- Formulation of a LPP
- Graphical solution
- Simplex method
- Revised simplex method
- Duality theory
- Dual simplex method
- Sensitivity analysis
- Parametric programming
- Transportation problem
- Assignment problem
- Travelling salesman problem
- Integer Programming
- Dynamic programming.
Reading:

MA6102

**FLUID DYNAMICS**

(3-1-0)4

Kinematics of fluids in motion - Equations of motion of fluid - Bernoulli's equation - some flows involving
axial symmetry - some special two-dimensional flows - Some three dimensional flows - axisymmetric flows -
Stokes' stream function - Viscous flows - the Navier-Stokes' equations of motion of viscous fluid - Steady
viscous flow in tubes of uniform cross section.

Reading:

MA6103

**NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS**

(3-1-0)4

Multistep Methods for Initial Value problems, Quasilinearization. Shooting methods - Finite Difference Methods:
Parabolic equations, Hyperbolic Equations, Laplace equation, Poisson equation, ADI methods.

Reading:

MA6104

**COMPLEX ANALYSIS**

(3-1-0)4

Functions of a complex variable - analytic functions - complex integration - Taylor's theorem - Laurent's
theorem - Cauchy's residue theorem - Conformal mapping - Bilinear transformation - Transformation by
elementary functions - representation of a polygon on a half plane - representation of any region on a circle.

Reading:

MA6105

**FUNCTIONAL ANALYSIS**

(3-1-0)4

Algebraic systems: Groups, rings, structure of rings, linear spaces, linear transformation algebras - Banach
spaces: Hahn-Banach theorem - the open mapping theorem - the conjugate of an operator - Hilbert spaces:
Orthogonal complements - orthonormal sets - conjugate space H*, adjoint of an operator - self-adjoint
operators - Normal and unitary operators - projections.

Reading:

MA6111

**MULTIVARIATE ANALYSIS**

(3-0-0)3

Multiple regression analysis, Multiple correlation, Partial Correlation, Multivariate analysis of variance -
Differences between MANOVA and discriminant analysis - conjoint analysis - canonical correlation analysis -
cluster analysis - cluster analysis decision process - multidimensional scaling - a decision framework for
perceptual mapping - correspondence analysis.

Reading:
MA6112  WAVELET ANALYSIS  (3-0-0)3
Wavelet transform - Haar wavelet expansion: Haar functions and Haar series, Haar function representation of Brownian motion - Multiresolution analysis - scaling functions, from scaling function to MRA - Wavelets in several variables: tensor product of wavelets, general formulation of MRA and wavelets in Rd.
Reading:

MA6113  FINITE VOLUME METHODS  (3-0-0)3
Introduction - Obtaining the Integral Form from the Differential Form - Finite Volume Meshes - Discretising the Semi-Integral Equation - Implementation of Finite Volume Schemes - The Shallow Water Equations - General FVS for the SWE - FVS for the 2D SWE on a Structured Mesh - Heuristic Time Step for a 2D SWE FVS.
Reading:

MA6106  MATHEMATICAL PROGRAMMING LABORATORY  (0-0-3)2
C language programs for Simplex method, Two phase method, Big-M method, Revised simplex method, Transportation algorithm, Dual simplex method, Assignment problem.

MA6151  OPERATIONS RESEARCH  (3-1-0)4
Nonlinear programming problem - Kuhn-Tucker conditions - Quadratic programming - min cost flow problem - max flow problem - CPM/PERT. Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.
Reading:

MA6152  FINITE ELEMENT METHOD  (3-1-0)4
Reading:

MA6161  MEASURE AND INTEGRATION  (3-0-0)3
Reading:
MA6162  **FUZZY MATHEMATICS AND APPLICATIONS**  (3-0-0)3

Crisp set theory - Fuzzy set theory - Propositional Logic - Predicate Logic - Fuzzy Relations - Fuzzy Logic - Switching functions and Switching circuits - Applications of fuzzy mathematics.

**Reading**:

MA6163  **COMPUTATIONAL FLUID DYNAMICS**  (3-0-0)3


**Reading**:

MA6164  **BIO-FLUID MECHANICS**  (3-0-0)3

Fundamental concepts of Biomechanics - Cardiovascular system : models on blood flow, flow in large blood vessels, microcirculation, pulsatile flow, stenotic region flow - peristaltic transport under long wave length approximation, peristaltic flow for small amplitudes - Flow in Renal tubules.

**Reading**:

MA6262  **MULTI OBJECTIVE PROGRAMMING**  (3-0-0)3

Multiple Criteria Decision Making problems - introduction to various methods with no articulation, apriori articulation, progressive articulation and posteriori articulation of preference information - optimization of multiple objective linear programming and non-linear programming problems. Goal programming.

**Reading**:

MA6263  **FINANCIAL MATHEMATICS**  (3-0-0)3

Hedging and pricing by arbitrage in discrete time models, Setting of binomial tree models - conditional expectation, martingale, change of measure, and representation - Brownian motion - Models for the interest rate in the national and international markets. Mathematical models of bond and stock prices, other derivative securities.

**Reading**:

MA6153  **SOFTWARE LABORATORY**  (0-0-3)2

Software packages (with a menu driven basis) have to be developed for the topics covered in the earlier semesters.
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## II Year II Semester

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Total number of credits for the course is 100

### LIST OF ELECTIVES

**Elective - I**

- MA 5261 Symbolic Computing
- MA 5262 Cryptography
- MA 5162 Mathematical Modelling

**Elective - II**

- MA 6211 Computer Graphics
- MA 6111 Multivariate Analysis
- MA 6113 Finite Volume Methods

**Elective - III and IV**

- MA 6261 Theory of Automata
- MA 6262 Multi-objective Programming
- MA 6263 Financial Mathematics
- MA 6264 Management Information Systems
- MA 6162 Fuzzy Mathematics and Applications
- MA 6163 Computational Fluid Dynamics
M.Sc. MATHEMATICS AND SCIENTIFIC COMPUTING

MA5101 REAL ANALYSIS (3-1-0)4
Basic Topology - metric spaces - compact sets - perfect sets - connected sets - Riemann Stieltje’s integral - Improper integrals - Uniform convergence of series - Power series - Fourier series.
Reading:

MA5102 DISCRETE MATHEMATICS (3-1-0)4
Sets and propositions - Permutations, combinations, numeric functions, generating functions - Recurrence relations and recursive algorithms - Relations and functions - Boolean algebra - Graphs and planar graphs, multigraphs and weighted graphs, Trees and cut-sets.
Reading:

MA5103 LINEAR ALGEBRA (3-1-0)4
Reading:

MA5104 ORDINARY DIFFERENTIAL EQUATIONS (3-1-0)4
Reading:

MA5105 PROGRAMMING AND DATA STRUCTURES (3-1-0)4
C-language: operators and expressions, control structures, functions, header files, scope rules, pointers and arrays, address arithmetic, command line arguments, structures - Stacks and Recursion - Lists - Searching and Sorting.
Reading:

**MA5106  NUMERICAL ANALYSIS**


Reading:

**MA5107  PROGRAMMING LABORATORY**

Simple programs in C languages using pointers, String manipulation, File processing, Program to implement Stacks and Queues, conversion of infix to post fix expression, Programs on Recursion, Programs for Searching, Programs for sorting.

**MA5151  INTEGRAL AND DISCRETE TRANSFORMS**


Reading:

**MA5152  PROBABILITY AND STATISTICS**

Probability - Bayes' Theorem - probability distributions with discrete and continuous random variables - joint probability mass function - testing of hypothesis for large and small samples - chi-square test linear correlation and linear regression - rank correlation - correlation of bivariate frequency distribution.

Reading:

**MA5153  PARTIAL DIFFERENTIAL EQUATIONS**

Formulation - linear and quasi-linear first order partial differential equations - Paffian equation - Equations of higher order: Method of solution for the case of constant coefficients - method of solution by separation of variables: Laplace's equation, Wave equation, Diffusion equation.

Reading:

**MA5251  DESIGN AND ANALYSIS OF ALGORITHMS**

Reading:

MA5252  **OOP WITH C++**  (3-1-0)4
Basic concepts of object-oriented programming - Structure of C++ program - Functions in C++ - Function overloading - C++ Program with class - Nesting of member functions - Constructors and Destructors - Operator overloading - Inheritance - Defining derived classes - Pointers, Virtual functions and Polymorphism.

Reading:

MA5261  **SYMBOLIC COMPUTING**  (3-0-0)3

Reading:

MA5262  **CRYPTOGRAPHY**  (3-0-0)3
Classical Cryptography - Secret Key Cryptosystems - Stream ciphers; Public Key Cryptosystems - Elliptic curves - basic facts; elliptic-curve cryptosystem; Digital Signature schemes; Zero-knowledge protocols, one-way functions; Advanced protocols for different applications, Copyright protection; Current trends in Cryptography.

Reading:

MA5162  **MATHEMATICAL MODELLING**  (3-0-0)3
Introduction - Microbial population models - Single species and two species population models - multispecies population models - optimal exploitation models - epidemic models - models in genetics - mathematical models in pharmacokinetics - models for blood flows.

Reading:

MA5253  **OOP WITH C++ LABORATORY**  (0-0-3)2
Programs with class, objects as Function arguments, Friendly functions, Constructors and Destructors, Operator overloading - overloading unary operators - overloading binary operators. Programs illustrating the implementation of various forms of inheritance - Programs for implementation of multiple inheritance.

MA6101  **MATHEMATICAL PROGRAMMING**  (3-1-0)4
Reading:

MA6102  FLUID DYNAMICS  (3-1-0)4

Kinematics of fluids in motion - Equations of motion of fluid - Bernoulli's equation - some flows involving axial symmetry - some special two-dimensional flows - Some three dimensional flows - axisymmetric flows - Stokes' stream function - Viscous flows - the Navier-Stokes' equations of motion of viscous fluid - Steady viscous flow in tubes of uniform cross section.

Reading:

MA6103  NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS  (3-1-0)4


Reading:

MA6104  COMPLEX ANALYSIS  (3-1-0)4

Functions of a complex variable - analytic functions - complex integration - Taylor's theorem - Laurent's theorem - Cauchy's residue theorem - Conformal mapping - Bilinear transformation - Transformation by elementary functions - representation of a polygon on a half plane - representation of any region on a circle.

Reading:

MA6201  DATA BASE MANAGEMENT SYSTEMS  (3-1-0)4

Data models, Data Independence, Database manager, Database Administrator - Entities and relationships, Mapping constraints - Structure of relational database - SQL - Domain constraints - First, Second and Third, Fourth and fifth normal forms - Structure of query optimizer - High performance transaction systems, long duration transactions.

Reading:

MA6211  COMPUTER GRAPHICS  (3-0-0)3


Reading:
MA6111 MULTIVARIATE ANALYSIS (3-0-0)3
Multiple regression analysis, Multiple correlation, Partial Correlation, Multivariate analysis of variance - Differences between MANOVA and discriminant analysis - conjoint analysis - canonical correlation analysis - cluster analysis - cluster analysis decision process - multidimensional scaling - a decision framework for perceptual mapping - correspondence analysis.
Reading:

MA6113 FINITE VOLUME METHODS (3-0-0)3
Introduction - Obtaining the Integral Form from the Differential Form - Finite Volume Meshes - Discretising the Semi-Integral Equation - Implementation of Finite Volume Schemes - The Shallow Water Equations - General FVS for the SWE - FVS for the 2D SWE on a Structured Mesh - Heuristic Time Step for a 2D SWE FVS.
Reading:

MA6202 DBMS LABORATORY (0-0-3)2
DDL, DML, DCL Statements Built in functions and Aggregate functions - SQL: Ordinary Query, Sub Query, Correlated Sub Query PL/SQL, Data types, Control Structures, Error handling mechanism, Subprograms - Stored procedures, Data base triggers and exception - RDBMS: Building forms using form designers, triggers.

MA6151 OPERATIONS RESEARCH (3-1-0)4
Nonlinear programming problem - Kuhn-Tucker conditions - Quadratic programming - min cost flow problem - max flow problem - CPM/PERT. Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.
Reading:

MA6152 FINITE ELEMENT METHOD (3-1-0)4
Reading:

MA6261 THEORY OF AUTOMATA (3-0-0)3
Finite Automata Deterministic finite automata (DFA), Non-deterministic finite automata (NFA), Non-deterministic finite automata with moves (NFA-), Equivalence of DFA, NFA and NFA-, Turing Machines: Turing machine model, example, Modification of Turing machines, Church’s hypothesis and Non-deterministic Turing machines.
Reading:
MA6262  
**MULTI OBJECTIVE PROGRAMMING**  
(3-0-0)3

Multiple Criteria Decision Making problems - introduction to various methods with no articulation, apriori articulation, progressive articulation and posteriori articulation of preference information - optimization of multiple objective linear programming and non-linear programming problems. Goal programming.

*Reading*:

MA6263  
**FINANCIAL MATHEMATICS**  
(3-0-0)3

Hedging and pricing by arbitrage in discrete time models, Setting of binomial tree models - conditional expectation, martingale, change of measure, and representation - Brownian motion - Models for the interest rate in the national and international markets. Mathematical models of bond and stock prices, other derivative securities.

*Reading*:

MA6264  
**MANAGEMENT INFORMATION SYSTEMS**  
(3-0-0)3


*Reading*:

MA6162  
**FUZZY MATHEMATICS AND APPLICATIONS**  
(3-0-0)3

Crisp set theory - Fuzzy set theory - Propositional Logic - Predicate Logic - Fuzzy Relations - Fuzzy Logic - Switching functions and Switching circuits - Applications of fuzzy mathematics.

*Reading*:

MA6163  
**COMPUTATIONAL FLUID DYNAMICS**  
(3-0-0)3

Basic Equations of Fluid Dynamics - Equations expressed in conservative form. Inviscid Flows. Incompressible potential flows; Viscous Fluid flows; pipe and open channel flows; generalized Rayleigh problem; starting flow in a channel problem; Numerical solution of a bi-harmonic equations-Stokes flows.

*Reading*:

MA6253  
**SOFTWARE AND SIMULATION LABORATORY**  
(0-0-3)2

Software packages (with a menu driven basis) have to be developed for the topics covered in the earlier semesters.