# Course Structure for 2yr M.Sc. in Applied Mathematics (2015-16)

<table>
<thead>
<tr>
<th>1st Semester</th>
<th>2nd Semester</th>
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<tbody>
<tr>
<td><strong>Theory</strong></td>
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<tr>
<td>Code</td>
<td>Subject</td>
</tr>
<tr>
<td>MMCC101</td>
<td>Real analysis</td>
</tr>
<tr>
<td>MMCC103</td>
<td>Discrete Mathematics</td>
</tr>
<tr>
<td>MAMC102</td>
<td>Ordinary Differential Equation</td>
</tr>
<tr>
<td>MMCF107</td>
<td>Data Structure with C++</td>
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<tr>
<td>MMCC104</td>
<td>Abstract Algebra</td>
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<tr>
<td>MAMC105</td>
<td>Linear Algebra</td>
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<thead>
<tr>
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<tr>
<td>Code</td>
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<tr>
<td>MMCF151</td>
<td>Data Structure using C++ Lab</td>
</tr>
<tr>
<td>MAMC152</td>
<td>Seminar</td>
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<tr>
<td>MAMC153</td>
<td>Ethics &amp; Human Values</td>
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<tr>
<td>Code</td>
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</tr>
<tr>
<td>MMCC304</td>
<td>Optimization Techniques</td>
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<tr>
<td>MMCC301</td>
<td>Functional Analysis</td>
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<tr>
<td>MAMC302</td>
<td>Probabilities &amp; Stochastic Process</td>
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<tr>
<td>Elect -I</td>
<td>3-1-0</td>
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<tr>
<td>Elect -II</td>
<td>3-1-0</td>
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<tr>
<td>Code</td>
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<tr>
<td>MMCC351</td>
<td>Optimization Lab</td>
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<tr>
<td>MMCC352</td>
<td>MAT lab</td>
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<tr>
<td>MAMC353</td>
<td>Industry Orient SEMINAR</td>
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### ELECTIVE-I

<table>
<thead>
<tr>
<th>Sl No</th>
<th>CODE</th>
<th>Course Description</th>
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<tbody>
<tr>
<td>1</td>
<td>MAME301</td>
<td>Fluid Dynamics</td>
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<tr>
<td>2</td>
<td>MAME302</td>
<td>Computational Finance</td>
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<tr>
<td>3</td>
<td>MAME303</td>
<td>Convex Analysis and optimization</td>
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<tr>
<td>4</td>
<td>MAME304</td>
<td>Parallel and Distributive Computing</td>
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<tr>
<td>5</td>
<td>MAME305</td>
<td>Number Theory and Cryptography</td>
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<tr>
<td>6</td>
<td>MAME306</td>
<td>Advanced Operating System</td>
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<tr>
<td>7</td>
<td>MAME307</td>
<td>Computer Architecture</td>
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### ELECTIVE-II

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<tr>
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<tbody>
<tr>
<td>1</td>
<td>MAME308</td>
<td>Numerical Solution of Differential Equation</td>
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<tr>
<td>2</td>
<td>MAME309</td>
<td>Advanced Statistics</td>
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<td>3</td>
<td>MAME310</td>
<td>Computational Biology</td>
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<td>4</td>
<td>MAME311</td>
<td>Graph Theory</td>
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<td>5</td>
<td>MAME312</td>
<td>Fourier Analysis</td>
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<tr>
<td>6</td>
<td>MAME313</td>
<td>Theory of Computation</td>
</tr>
<tr>
<td>7</td>
<td>MAME314</td>
<td>Finite Element Method</td>
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### ELECTIVE-III

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<tbody>
<tr>
<td>1</td>
<td>MAME401</td>
<td>Computational Fluid Dynamics</td>
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<tr>
<td>2</td>
<td>MAME402</td>
<td>Distribution Theory and Sobolev spaces</td>
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<tr>
<td>3</td>
<td>MAME403</td>
<td>Artificial Intelligence</td>
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<tr>
<td>4</td>
<td>MAME404</td>
<td>Machine learning</td>
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<tr>
<td>5</td>
<td>MAME405</td>
<td>Hydrostatics</td>
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<td>6</td>
<td>MAME406</td>
<td>Fuzzy and Rough set theory</td>
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<tr>
<td>7</td>
<td>MAME407</td>
<td>Numerical Optimization</td>
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FIRST SEMESTER

MMCC 101 REAL ANALYSIS (3-1-0)

Module - I: (14 Hours)

Introduction to Metric spaces, compact set, connected set, Weistrass Approximation Theorem, Sequence and series of function, Uniform convergence. Lebesgue measure:

Module - II: (14 Hours)


Module - III: (12 Hours)

Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation - Additive property of total variation - Total variation on $[a, x]$ as a function of $x$ - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation.

The Riemann Stieltjes Integrals: Introduction, Notation, The definition of Riemann Stieltjes Integral, Linear operators, Integration by parts, Change of variable in Riemann Stetiltjes integrals, Reduction to a Riemann Integral, Euler’s summation formula, Monotonically increasing integrals.

Text Book:

1. Real Analysis by H.L Royden(3rd edition) Chapter 3(3.1 to 3.5), Chapter(4.1 to 4.4), Chapter(11), Chapter(12.1 to 12.7).
Reference Book:
7. Measure theory and integration by G. De Barra (wiley estern ltd)

**MMCC 103 DISCRETE MATHEMATICS (3-1-0)**

**Module-I : (13 Hours)**

**Module-II : (14 Hours)**
Introduction to graph theory, Graph terminology, Representation of graphs, Isomorphism, Connectivity, Euler and Hamiltonian paths, Shortest path problems, Planar graph, Graph coloring, Introduction to trees, Application of trees, Tree Traversal, Minimum Spanning tree.

**Module-III : (13 Hours)**
Matrix representation of a graph: Basic ideas of Incidence matrix, sub matrix, circuit matrix fundamental circuit matrix, cut set matrix, path matrix and adjacency matrix, Coloring: Chromatic number, chromatic partitioning, chromatic polynomial, matching, covering. Algebraic systems, Lattices, Distributive and Complemented Lattices, Boolean Lattices and Boolean Algebra, Boolean Functions and Boolean Expressions.
**Text Books:**
   Chapters: 1, 2(2.4), 4, 6(6.1, 6.2, 6.4-6.6), 7, 8, 9

   Chapters: 10 (10.1- 10.10), 11(11.1 – 11.7)

**Reference:**
   Chapters : 1,2,3,4(4.1-4.5), 5, 6(6.1-6.5)
   Chapters: 10 (10.1- 10.10), 11(11.1 – 11.7)

**MAMC102 ORDINARY DIFFERENTIAL EQUATION(3-0-0)**

**Module-I (8 hours)**
Existence and uniqueness of Solution: Lipchitz condition, Gronwall inequality, Successive approximations, Picard’s theorem, Second order linear equations, Separation and comparison theorems, Solutions in series, Legendre and Bessel functions

**Module-II (10 hours)**
Systems of differential equations: Existence and uniqueness of solution of systems, Systems of linear Differential equations, nth order equations of a first order system, Fundamental matrix, Non- homogeneous linear systems, linear systems with constant coefficients ,Eigen values and Eigen vectors

**Module-III (12 hours)**

Books Recommended:
Text book:

Tyn Myint-U: Ordinary Differential Equations, New York, Chapters: 2, 3(3.1-3.5), 4(4.1-4.4), 5(5.1-5.6), 6(6.1-6.4), 7(7.1-7.3), 8(8.1-8.5)

Reference Books:


**MMCF 107 DATA STRUCTURE using C++ (3-0-0)**


**Module – II [10 Hours]** Dynamic storage management-garbage collection and compaction, infix to post fix conversion, postfix expression evaluation. Trees: Tree terminology, Binary tree, Binary search tree, General tree, B+ tree, AVL Tree, Complete Binary Tree representation, Tree traversals, operation on Binary tree-expression Manipulation.

**Module – III [10 Hours]** Graphs: Graph terminology, Representation of graphs, path matrix, BFS (breadth first search), DFS (depth first search), topological sorting, Warshall’s algorithm (shortest path algorithm.) Sorting and Searching techniques – Bubble sort, selection sort, Insertion sort, Quick sort, merge sort, Heap sort, Radix sort. Linear and binary search methods, Hashing techniques and hash functions.

**Text Books:** 1. Gilberg and Forouzan: “Data Structure- A Pseudo code approach with C++” by Thomson publication


3. “Fundamental of Data Structure” (Schaums Series) Tata-McGraw-Hill. 22 BE
MMCC-104  ABSTRACT ALGEBRA (3-1-0)

Module-I (14 hours)

Normal subgroup, Isomorphism theorem, Automorphisms, Permutation group: Cyclic decomposition and Alternating group $A_n$. Structure theorems for groups: Direct Product, finitely generated abelian group. Structure theorem for groups: Invariants of a finite abelian group, Sylows theorem. Unique factorization domain, Principal ideal domain, Euclidean domains, polynomial rings over UPD.

Module-II(13 hours)


Module-III (13hours)

Galois Theory: Automorphism groups and fixed fields, Fundamental theorem of Galois theory. Application of Galois theory to classical problems: Roots of unity and Cyclotomic polynomials, Cyclic extensions, Polynomials solvable by radicals, Symmetric functions, Ruler and compass constructions.

Text Book


Reference Books:

MAMC 105  LINEAR ALGEBRA  (3-1-0)

Module-I (14-hours)

Geometric interpretation of solution of system of equations in two and three variables; matrix notation; solution by elimination and back substitution; interpretation in terms of matrices, elimination using matrices; elementary matrices, properties of operations on matrices. Definition and uniqueness; non-existence in general: singular matrices; calculation of inverse using Gauss-Jordan elimination; existence of one sided inverse implies invertibility; decomposition of a matrix as product of upper and lower triangular matrices. Vector spaces and Subspaces, Solving $Ax=0$ and $Ax=b$, Linear Independence, Basis and Dimension, The four fundamental Subspaces, graph and networks, Linear Transformations.

Module-II (13-hours)


Module-III (13-hours)

Eigen values and eigenvectors, Diagonalisation of a Matrix, Difference equations and powers $A^k$, Markov Matrices, Differential equations and $e^{At}$, stability of differential equation, complex Matrices, unitary Matrices, similarity transformations, Jordan Form, mínima, maxima and saddle points, tests for positive definiteness, Test for positive definiteness, singular value decomposition, minimum principles.

Text Book:

MMCF 151 DATA STRUCTURE LAB (0-0-3)

(Minimum 10 experiments to be done)

**Experiment No.1** Write a C++ program to perform matrix multiplication using array.

**Experiment No.2** (a) Write a C program to create a stack using an array and perform (i) push operation (ii) pop operation  
(b) Write a C program to create a queue and perform i) Push ii) pop iii) Traversal

**Experiment No. 3** Write a C++ program that uses Stack operations to perform the following: i) Converting infix expression into postfix expression ii) Evaluating the postfix expression

**Experiment No. 4** Write a C++ program that uses functions to perform the following operations on Single linked list: i) Creation ii) Insertion iii) Deletion iv) Traversal in both ways

**Experiment No. 5** Write a C++ program that uses functions to perform the following operations on Double linked list: i) Creation ii) Insertion iii) Deletion

**Experiment No. 6** Write a C++ program that uses functions to perform the following operations on Binary Tree: i) Creation ii) Insertion iii) Deletion

**Experiment No. 7** Write C++ programs that use both recursive and non recursive functions to perform the Linear search operation for a Key value in a given list of integers: i) Linear search

**Experiment No. 8** Write C++ program that use both recursive and non recursive functions to perform the Binary search operation for a Key value in a given list of integers:

**Experiment No.9** Write a C++ program that implement Bubble Sort method to sort a given list of integers in descending order.

**Experiment No.10** Write a C++ program that implement Quick Sort method to sort a given list of integers in ascending order.
Second Semester

MMCC 201 Topology (3-1-0)

Module –I : (14 Hours)

Countable and uncountable set, Infinite sets and the Axiom of choice, Well-ordered sets. Topological spaces, Basis and sub basis for a topology, The order, product and subspace topology, closed sets and limit points. Continues function and homeomorphism, Metric topology, Connected spaces, connected subspaces of the real line, Components and local connectedness.

Module –II : (14 Hours)

Compact spaces, Basic properties of compactness, Compactness and finite intersection property, Compact subspaces of the real line, Compactness in metric spaces, Limit point compactness, Sequential compactness and their equivalence in metric spaces, Local compactness and one point compactification.

Module –III : (12 Hours)


Text Book :


Chapter: 1(7,9,10),2(excluding section 22), 3, 4 (excluding section 36), 5.

Reference Book:


General Topology, by S.Nanda and S.Nanda, Macmillan India.
MMCC 202  Numerical Analysis (3-0-0)

Module –I (10 Hours)

Solution of equations in one and two variables: Mullers method, for two variables; fixed pt iteration, Newton’s method.

Interpolation; Hermite, cubic spline and piecewise interpolation ,Natural cubic splines, B. Splines

Numerical differentiation; first order derivative, higher order derivative, Richardson Extrapolation.

Module -II : (10 Hours)

Numerical integration; Romberg integration, Gaussian Quadrature (2-pt,3-pt,4-pt),asymptotic error formula and their applications , Newton- Cotes rules..

Numerical solution to ODE; Taylor’s series methods ,Adaptive Runge - Kutta method, predictor- corrector method, convergence and stability theory for multistep methods,

Module -III: (10 Hours)

Matrix eigen value problem; power method ,shifted power method, inverse power ,RQ-method, error and stability results.

Numerical solution to partial differential equations; parabolic,elliptic ,Hyperbolic equations using finite difference method.

Text Book ::

1. Numerical Analysis: Richard L. Burden.(chapter – 3,4,5,6,7)

Reference Books :

1. Advanced numerical methods ,L.V. Fusset
3. Numerical methods for Engineers by Chapra & Canale , TMH
MMCC 203 Complex Analysis (3-1-0)

Module-I (14 Hours)

The complex number system: The real numbers, The field of complex numbers, the complex plane, polar representation and roots of complex numbers, Line and half planes in the complex plane. Power series and radius of convergence, analytic function, Power series representation of analytic functions, Cauchy- Riemann equation, analytic function as mapping and its Mobius transformation.

Module-II (14 Hours)

Complex integration: Zeros of analytic function, entire function, Liouville’s theorem, fundamental theorem of algebra, maximum modulus theorem, Index of a closed curve, Cauchy's theorem and Cauchy's integral formula, Morera’s theorem.

Module-III (12Hours)

Classification of singularity, Poles, absolute convergence, Laurent series development, Residue theorems, evaluation of integrals by using residue theorem, Argument principle, Rouche’s theorem, Maximum Modulus theorem, Schwarz’s Lemma.

Text Book:

1. Functions of one Complex variable- J. B. Conway (springer Verlag, International student edition, Narosa Publishing house,

Chapter-1(1.1-1.5), Chapter-3(3.1-3.3), Chapter-4(4.2 - 4.5), Chapter-5(5.1-5.3),
Chapter-6(6.1 - 6.2).

Reference Books:

2. Complex Analysis by Alhfors, TMH
MAMC 204  Partial Differential Equations (3-0-0)

Module-I (10 Hours)

PARTIAL DIFFERENTIAL EQUATIONS OF 1\textsuperscript{ST} ORDER: Formation and solution of PDE-Integral surfaces- Cauchy problem for 1\textsuperscript{st} order equation-orthogonal surfaces-First order non linear-characteristics compatible system-Charpits Method. Classification of second order PDE-Canonical forms- Adjoint operators-Riemann’s method.

Module-II (10 Hours)

ELLIPTIC DIFFERENTIAL EQUATIONS: Derivation of Laplace & Poisson equation-BVP-Separation of variables-Dirichlets and Newmann problem for a rectangle-Solution of Laplace equation in Cylindrical and spherical coordinates-Examples.

PARABOLIC DIFFERENTIAL EQUATIONS: Formation and solution of Diffusion equation-Dirac-Delta function- Separation of variables method-Solution of Diffusion equation in Cylindrical and spherical coordinates-Examples.

Module-III (10 Hours)

HYPERABOLIC DIFFERENTIAL EQUATIONS: Formation and solution of one dimensional wave equation-Canonical reduction-D’Alembert’s solution-IVP and BVP for two dimensional wave equation-Periodic solution of one dimensional equation in Cylindrical and spherical coordinates-Uniqueness of the solution for the wave equation-Duhamel’s Principle-Examples.

TEXT BOOK:

K.Sankar Rao, Introduction to Partial Differential Equations, 2\textsuperscript{nd} Edition, Prentice Hall of India, New Delhi,2005

Chapters:0(0.4-0.11,(omit 0.11.1)),1(1.1-1.5),2(2.1,2.2,2.5-2.7,2.10-2.13),3(3.1-3.7,3.9),4(4.1-4.12 omit (4.5,4.6 & 4.10)).

Reference Books


MAMC 205  Continuum Mechanics (3-1-0)

Module-I (14 Hours)


Module-II (14 Hours)


Module-III (12 Hours)


TEXT BOOKS

Chapters 2(2.4,2.5.4,2.5.5),3(3.2,3.3,3.4.1),5(5.2.2-5.2.4,5.3.1-5.3.3,5.4.2,5.4.4,5.4.5),6(6.2.2-6.2.7,6.3.2-6.3.4,6.4.2-6.4.3)


REFERENCES

MAMF206 Relational Database Management System (3-0-0)

Module I: (10 hours)
Database System Architecture - Data Abstraction, Data Independence, Data Definitions and Data Manipulation Languages. Data models - Entity Relationship (ER), Mapping ER Model to Relational Model, Network. Relational and Object Oriented Data Models, Integrity Constraints and Data Manipulation Operations.

Module II: (10 hours)
Relation Query Languages, Relational Algebra and Relational Calculus, SQL. Relational Database Design: Domain and Data dependency, Armstrong’s Axioms, Normal Forms, Dependency Preservation, Lossless design. Query Processing Strategy.

Module III: (10 hours)

Text Books:
1. Database System Concepts by Sudarshan, Korth (McGraw-Hill Education)
2. Fundamentals of Database System By Elmasari & Navathe- Pearson Education

References Books:
(1) An introduction to Database System – Bipin Desai, Galgotia Publications
(2) Database System: concept, Design & Application by S.K. Singh (Pearson Education)
(3) Database management system by leon & leon (Vikas publishing House).
(4) Fundamentals of Database Management System – Gillenson, Wiley India
1. Write a computer oriented algorithm & the corresponding C Program to fit a straight line of the form \( y = a x + b \), for a given data, using the method of least square.

2. Write a computer oriented algorithm & the corresponding C Program to fit a nth degree polynomial of the form \( y = \sum_{i=0}^{n} c_i x^i \) for a given data by the method of least square.

3. Write a computer oriented algorithm & the corresponding C Program to find the smallest positive root using fixed point iteration method.

4. Write a computer oriented algorithm & the corresponding C Program to find the smallest positive root using Newton- Raphson method.

5. Write a computer oriented algorithm & the corresponding C Program to find the solution of the system of linear equations using Gauss Seidel Method.

6. Write a computer oriented algorithm & the corresponding C Program to interpolate \( y \) using the given pair of values of \( x \) and \( y \) by Lagrange's interpolation.

7. Write a computer oriented algorithm & the corresponding C Program to find the derivative at the initial point using Newton 's Forward Difference Method.

8. Write a computer oriented algorithm & the corresponding C Program to find the derivative at the final point using Newton 's Backward Difference Method.

9. Write a computer oriented algorithm & the corresponding C Program to integrate Numerically using Trapezoidal & Simpson's Rule.

10. Write a computer oriented algorithm & the corresponding C Program to integrate Numerically using Gauss Quadrature Rule.

11. Write a computer oriented algorithm & the corresponding C Program to solve the Differential Equation \( \frac{dy}{dx} = f(x, y) \), \( y(x_0) = y_0 \) at the specified pivotal points by using the Runge-Kutta Method of 4th order.
MACF252 Relational Database Managements System Lab(0-0-3)

1. Use of SQL syntax: insertion, deletion, join, updation using SQL. (1 class)
2. Programs on join statements and SQL queries including where clause. (1 class)
3. Programs on procedures and functions. (1 class)
4. Programs on database triggers. (1 class)
5. Programs on packages. (1 class)
6. Programs on data recovery using check point technique. (1 class)
7. Concurrency control problem using lock operations. (1 class)
8. Programs on ODBC using either VB or VC++. (1 class)
9. Programs on JDBC. (1 class)
10. Programs on embedded SQL using C / C++ as host language. (1 class)