

Department: Mathematics

Course: M.Sc. (IMCA)– 120 Credits Program Structure

Duration: 3 Years

Semester I -Total Number of Credits -20		
Core Courses		
Subject Code	Subject Title	Number of Credits
MI-101	Algebra	4
MI-102	Linear Algebra	4
MI-103	Discrete Mathematics	4
MI-104	Computer Organization	4
MI-105	Programming in C	4
Elective Courses - NIL		

Semester II -Total Number of Credits -20		
Core Courses		
Subject Code	Subject Title	Number of Credits
MI 201	Foundations of Analysis	4
MI 202	Differential Equations	4
MI 203	Data Structures	4
MI 204	Programming in C++	4
MI 205	Operating Systems	4
Elective Courses - NIL		

Semester III - Total Number of Credits -20		
Core Courses		
Subject Code	Subject Title	Number of Credits
MI-301	Complex Analysis	4
MI-302	Database management systems	4
MI-303	Theory of Computer Science	4
MI-304	Design and Analysis of Algorithms	4
MI-305	Computer Graphics	4
Elective Courses -NIL		

Semester IV - Total Number of Credits -20		
Core Courses		
Subject Code	Subject Title	Number of Credits
MI-401	Operations Research	4
MI-402	Rings and Fields	4
MI-403	Software Engineering	4
MI-404	Computer Networks	4
MI-405	Programming with JAVA	4
Elective Courses*		
Subject Code	Subject Title	Number of Credits
MI-406	Computational Geometry	
Mi-407	Data Mining	4
MI-408	Artificial Intelligence	4
MI-409	Cryptography	4
MI-410	Evolutionary Computing and Image Processing	4
MI-411	Advanced DBMS	4
MI-412	Probability and Statistics	4

Semester V - Total Number of Credits -20		
Core Courses		
Subject Code	Subject Title	Number of Credits
MI-501	Coding Theory	4
MI-502	Mathematics course	4
Elective Courses		
Subject Code	Subject Title	Number of Credits
MI-503	Programming with Advanced Java	4
Mi-504	Programming with DOT NET	4
MI-505	Programming using mobile technologies	4
MI-506	Compiler construction	4
MI-507	Integral Transforms	4
MI-508	Financial Mathematics	4
MI-509	Advanced Algorithms	4
MI-510	Managerial Techniques using Operations Research	4
MI-511	Mathematical Modelling and Simulation	4
MI-512	Fuzzy Sets and Fuzzy Logic	4
MI-513	Cloud Computing	4
MI-514	Object Oriented Modelling and Design	4
MI-515	Software Project Development	4
MI-516	Differential Geometry	4

Semester VI - Total Number of Credits -20		
Elective Courses		
Subject Code	Subject Title	Number of Credits
MI-601	Industrial Training /Institutional project	12
MI-602	A student can select two electives from the list of electives provided in semester IV and Semester V	4
MI-603		4

Note-

1. * - A student can choose at most 2 electives in 4th Semester for the completion of 8 credits of 6th Semester.
2. Each student is supposed to attend 5 teaching-learning hours every week per subject.
3. Each Course of 4 credits will be conducted as follows:
 - i) Direct Teaching (Theory) Hours for a class as a whole- **4 hrs per week by the teacher**
 - ii) Direct Teaching (Problem Session/Applications) Hours for a batch of 10/15/20 students - **4 or 3 (as applicable) hrs per week by the teacher**
 - iii) Direct Teaching (Practical) Hours for a batch of 10/15/20 students -**3 hrs per batch per week by the teacher**
4. For the Course MT-601, a teacher will be assigned (as a mentor) to a group of 2/3/4 students for at least one semester and is supposed to devote at least 2 hrs each week to monitor and coordinate the industrial project.

Department: Mathematics

Course: M.Sc. (IMCA)– 120 Credits Program (Syllabi)

Duration: 3 Years

Preamble and Related Details

Duration: The entire Programme is a Three year and six semester full time Programme.

Number of Courses: For semesters 1,2 and 3, there will be FIVE courses. For semester 4 and 5, there will be 5 or 6 courses. The last semester will be Industrial training/Institutional project and 0 or 1 or 2 theory courses. For every course except the course MT-601 there will be 4 hours classroom teaching and 1 hours would be reserved for either Laboratory work/Problem solving session/ related activity

Award of Credits:Each Theory course will be of 4 credits. For every course in all the semesters there will be two aspects of the conduct of the course first is the theory course and second is practical/laboratory work for each course. In general, each semester is of 5 courses and 20 credits (This is not applicable for Industrial training in 6th semester of M.Sc.-IMCA).

ATKT Rules:

- Each regular student will have to appear for all the 20 credits of the respective semester.
- A student who wishes to take admission to the second year M.Sc.-IMCA should have earned at least 20 credits out of 40 credits of the First year M.Sc.-IMCA.
- A student who has been admitted to second year of M.Sc. -IMCA can register for 5th semester and 6th semester.

Evaluation Rules:

- Each course will carry 100 marks except MT-601.
- There will be Continuous Evaluation (CA) and End Term Evaluation mechanism (ETE) for each course and carry 50 marks each.
- The assessment of 15 credits towards VIth semester (Full Time Industrial Training / Institutional project) will be carried out as follows:
 - i) A student will inform the Department about the joining date of the above mentioned training.

- ii) The student will have to make minimum two presentations, one in the third month and the other at the end of the training programme. These presentations will be considered towards CA.
 - iii) The student will have to submit a Dissertation/Report to the department which will be assessed towards course credits.
- 50% marks of the course towards CA will be based on tests (minimum 2). In addition, a teacher may consider one or more of the following evaluation systems.
 - i) Home Assignment(s)
 - ii) Seminar/Presentation by the student
 - iii) Laboratory assignment
 - iv) Group Discussions
 - v) Research Paper Review
 - vi) Technology Demonstration
 - vii) Mini projects in group of maximum 2 members.
- If a student fails in a course of any semester then the student can appear only for the End of Semester Examination of the following semester. However, he/she can improve the continuous assessment (CA) performance in any of the forthcoming semesters in which the course is subsequently conducted and in this case, the student will have to appear for End of Semester Examination also for the said course.

Completion of Degree Programme:

- i) In order to pass the M.Sc. (Industrial Mathematics with Computer Applications) Course a student has to obtain 120 credit points, i.e., a student has to pass 28 subjects (including Soft Skills (Audit course)) along with the degree project. Those students who wish to complete degree project in Industries are allowed maximum 7 subjects in semester IV and semester V, so that the student can complete only degree project in semester VI.
- ii) If a student has failed in a course then the said course will not be taken into account for calculating GPA and overall grade. In fact, all the courses in which a student has passed will be taken into account for calculating the GPA and overall grade.

Semester-I

MT 101 : Algebra

1. Introduction to Groups: Symmetries of a Square, The Dihedral Groups, Definition and Examples of Groups, Elementary Properties of Groups.
2. Subgroups and Cyclic Groups: Terminology and Notation , Subgroup Tests, Examples of Subgroups, Properties of Cyclic Groups, Classification of Subgroups of Cyclic Groups, Properties of Cosets, Lagrange's Theorem and Consequences.
3. Permutation Groups : Definition and Notation , Cycle Notation , Properties of Permutations, An application of Cosets to Permutation Groups, The Rotation Group of a Cube and a Soccer Ball.
4. Group Homomorphism and Isomorphism: Definition and Examples of Homomorphism, Properties of Homomorphism. Definition and Examples of Isomorphism, Properties of Isomorphism, Cayley's Theorem, The First Isomorphism Theorem, Automorphism.
5. External Direct Products: Definition and Examples, Properties of External Direct Products, The Group of Units Modulo n as an External Direct Product, Applications.
6. Normal Subgroups and Factor Groups: Normal Subgroups, Factor Groups, Applications of Factor Groups, Internal Direct Products.
7. Fundamental Theorem of Finite Abelian Groups: The Fundamental Theorem, The Isomorphism Classes of Abelian Groups.

Reference Books:

- i. Joseph A. Gallian, Contemporary Abstract Algebra (Fourth Ed.), Narosa, 1999. (Part 2 : Groups)
- ii. P. B. Bhattacharya, S. K. Jain and S. R. Nagpal, Basic Abstract Algebra (Second Ed.), Cambridge Univ. Press (Indian Ed. 1995)
- iii. I. S. Luthar and I. B. S. Passi, Algebra-Vol. 1: Groups, Narosa, New Delhi, 1996.

MT 102 : Linear Algebra

- 1 Gaussian elimination, echelon forms, properties of determinants, complexity of calculating determinants.
- 2 Vector spaces, subspaces, linear independence, basis, dimension, linear transformations.
- 3 Orthogonal vectors and subspaces, orthogonal matrices, projections, least squares, orthogonal basis Gram Schmidt.
- 4 Eigenvalues and eigenvectors, diagonalization, Jordan form, difference equations, A^k , Differential equations, and e^{At} .
- 5 Positive definite matrices, maxima, minima, saddle points, singular value decomposition, matrix norms, condition numbers, computation of eigenvalues, iterative methods for $Ax=b$.

Reference Books :

- i. Linear Algebra and its applications, by Gilbert Strang.
- ii. Linear Algebra and its applications, by David Lay.

MT103 : Discrete Mathematics

1. Order Relations and Structures: Partially ordered set, Extremal Elements of Partially ordered sets, Lattices, Finite boolean algebras, Functions on Boolean algebras, Circuit designs.
2. Trees: Trees, Labelled Trees, Tree Searching, Undirected Trees, Minimal Spanning Trees
3. Topics in Graph Theory: Graph, Euler Paths and Circuits, Hamiltonian Paths and Circuits, Transport Networks, Matching Problems, Coloring Graphs,
4. Combinatorics: Combination, Permutation, Generating Functions, Ordinary and Exponential Generating functions, Recurrence Relation, Methods of Solution of Recurrence Relation, Substitution Method, Characteristic Method, Generating Function Method, Principle of Inclusion and Exclusion.

Reference Books:

- i. Kolman, Busby, Ross, Discrete Mathematical Structures, Fifth Edition (Pearson Education).
- ii. Purna Chandra Biswal, Discrete Mathematics and Graph Theory, Second Edition (PHI.).
- iii. Alan Tucker, Applied Combinatorics, Forth Edition (John Willey).

MT 104 : Computer Organization

1. Overview of Computer Organization: Introduction, Basic Terms and Notation, Programmer's View, Advantages of High-Level Languages, Why Program in Assembly Language? Architect's View, Implementer's View. The Processor: Pipelining, Memory: Basic Memory Operations, Byte Ordering, Two Important Memory Design Issues, Input/Output, Historical Perspective, Technological Advances
2. Introduction to Digital Logic: Introduction, Basic Concepts and Building Blocks, Logic Functions, Boolean Algebra, Logic Circuit Design Process, Deriving Logical Expressions from Truth Tables, Simplifying Logical Expressions, Generalized Gates, Multiple Outputs, Implementation Using Other Gates
3. Combinational Circuits: Introduction, Multiplexers and Demultiplexers, Decoders and Encoders, Comparators, Adders, Programmable Logic Devices, Arithmetic and Logic Units
4. Sequential Logic Circuits: Introduction, Clock Signal, Latches, Flip-Flops, Example Sequential Circuits, Sequential Circuit Design
5. Processor Organization and Performance: Introduction, Number of Addresses, Flow of Control, Instruction Set Design Issues, Microprogrammed Control, Performance
6. RISC and CISC processor architectures
7. CISC (case study of Intel Processors)

8. RISC (case study of ARM processors)
9. Memory System Design : Introduction, A Simple Memory Block , Techniques to Connect to a Bus, Building a Memory Block, Building Larger Memories Cache Memory : Introduction , How Cache Memory Works , Why Cache Memory Works, Cache Design Basics
10. Virtual Memory: Introduction, Virtual Memory Concepts, Page Table Organization, Page Table Entries, The Translation Look aside Buffer, Page Table Placement, Inverted Page Table Organization, Segmentation
11. Input / Output Organization Introduction, Accessing I/O Devices, I/O Data Transfer, Error Detection and Correction, System Buses and their architecture.
12. Interrupts: Introduction, taxonomy of Interrupts, Hardware Interrupts, Software Interrupts, and Exceptions.

Reference Books:

- i. Computer System Architecture 3 Edition (Paperback), M. Morris Mano, Pearson Education, ISBN-9788131700709
- ii. Computer Architecture and Organization : An Integrated Approach (Paperback), Miles Murdocca, Vincent Heuring, Wiley, ISBN-9788126511983
- iii. Digital Logic and Computer Design 1st Edition (Paperback), M. Morris Mano, Pearson Education, ISBN-9788177584097
- iv. Computer Organization and Design : The Hardware/Software Interface 4 Edition (Paperback), David A. Patterson, John L. Hennessy, , Morgan Kaufmann Publishers, ISBN-978813122274
- v. Computer Organization, Design and Architecture, Shiva 0004 Edition (Hardcover), Sajjan G. Shiva, CRC Press, ISBN-9780849304163

MT 105 : Numerical Recipes in C

1. Introductory Concepts: Introduction to computer, Computer characteristics, Types of programming languages, Introduction to C.
2. C Fundamentals: The character set, identifier and keywords, data types, constants, variables and arrays, declarations, expressions, statements, symbolic constants.
3. Operators and Expressions: Arithmetic operators, unary operators, relational and logical operators, assignment operators, library functions.
4. Data Input and Outputs: Preliminaries, single character input-getchar() function, single character output-putchar() function, entering input data-scanf() function, writing output data- printf() function, formatted inputoutput-gets() and puts() functions.
5. Preparing and Running a Program: Planning and writing a C Program, compiling and executing the program.
6. Control Statements: Preliminaries, the while statement, the do- while statement, the for statement, nested loops, the if-else statement, the switch statement, the break statement, the continue statement, the comma operator, the goto statement.
7. Functions: A brief overview, defining a function, accessing a function, passing arguments to a function, specifying argument data types, function prototypes, recursion.

8. Program Structures: Storage classes, automatic variables, external variables, static variables, multifile programs, more about library functions.
9. Arrays: Defining an array, processing an array, passing arrays to a function, multidimensional arrays, arrays and strings.
10. Pointers: Fundamentals, pointer declarations, passing pointer to a function, pointer and one dimensional arrays, operations on pointers, pointers and multidimensional arrays, array of pointers, pointer to a function, passing functions to other functions, more about pointer declarations.
11. Structures and Unions: Defining a structure, processing a structure, user-defined data types (typedef), structures and pointers, passing structure to a function, self-referential structures, unions.
12. Data Files: Opening and closing a data file, creating a data file, processing a data file, unformatted data files.

Practical should cover the programs in C of the following methods/ topics in Numerical Analysis:

- Bisection method.
- Newton's method
- Secant method
- Newton's method for two non linear equations
- Divided difference interpolation formula
- Aitken's formula
- Hermite's interpolation
- Double interpolation
- Gauss Elimination method, Gauss-Jordan method,
- Linear equation solution, LU decomposition
- Gauss- Seidel iteration
- Numerical differentiation
- Numerical Integration
- Trapezoidal rule
- Simpson's 1/3 –rule
- Simpson's 3/8 rule
- Numerical Solution of Ordinary differential Equations by Taylor series: Solution
- Numerical Solution of Ordinary differential Equations by Picard Method of successive approximations
- Numerical Solution of Ordinary differential Equations by Euler's Method and by Modified Euler Method
- Numerical Solution of Ordinary differential Equations by Runge- Kutta Methods
- Jacobi method to find eigenvalues and eigenvectors of a real symmetric matrix

- Householder method to find eigenvalues and eigenvectors of a real symmetric matrix

Reference Books:

- i. Byron S, Gottfried, Programming with C, Schaum's Outline series
- ii. W. H. Press, S. A. Teukolsky et. al., Numerical recipes in C, The art of Scientific Computing
- iii. Yashwant Kanetkar, Let us C, BPB Publications
- iv. Brian W, Kernighan, Dennis M, Ritchie, The C Programming Language, Prentice Hall Publication

Semester - II

MT 201 : Foundations of Analysis

1. A Taste of Topology: Metric space concepts, Compactness, Connectedness, Coverings, Cantor sets.
2. Functions of a Real Variable: Differentiation, Riemann integration, Series.
3. Function Spaces: Uniform convergence and $C^0[a, b]$, Power series, Compactness and equicontinuity in C^0 .
4. Multivariate Calculus: Derivatives, Higher derivatives, Smoothness classes, Implicit and inverse functions.
5. Lebesgue Theory: Outer measure, Measurability, Regularity, Lebesgue integrals.

Reference Books:

- i. C. C. Pugh, Real Mathematical Analysis, Springer, New Delhi, 2004. (Ch. 2: Sec 1 to 5; Ch. 3, Ch. 4: Sec 1 to 5; Ch. 5: Sec 2 to 5; Ch. 6: Sec 1 to 4.)
- ii. N. L. Carothers, Real analysis, Cambridge University Press India, 1999.
- iii. H. Royden, Real Analysis, Third Edition, Prentice Hall of India, 1988.

MT 202 : Differential Equations

1. Prerequisites: Linear equations of the first order.
2. Linear equations with constant coefficients: Second order homogeneous equations, Initial value problems, Linear dependence and independence, Nonhomogeneous equations of n-th order, Algebra of constant coefficients.
3. Linear equations with variable coefficients : Initial value problems, Solutions of the homogeneous equation, Wronskian and linear independence, Reduction of order, Nonhomogeneous equations, Legendre equation.
4. Linear Equations with regular singular points: Euler equation, Second order equation with regular singular points, Exceptional cases, Bessel equation.
5. Existence and uniqueness of solutions to first order equations: Separation of variables, exact equations, Method of successive approximations, Lipschitz condition, Approximation to and uniqueness of solutions.
6. Existence and uniqueness of solutions to systems and n-th order equations: Complex n-dimensional space, Systems as vector equations, Existence and uniqueness of solutions to systems, Existence, Uniqueness for linear systems and equations of order n.

Reference Books:

- i. E. A. Coddington, An Introduction to Ordinary Differential Equations (Prentice-Hall).
- ii. G. F. Simmons and S. G. Krantz, Differential Equations (Tata McGraw-Hill).

MT203: Data Structures

1. Introduction to Data Structures & Abstract Data Types, review of arrays and strings, structures and pointers concepts in C/C++, recursion and its efficiency.
2. Stacks: Operations and applications (Infix, Postfix and prefix expression handling),
3. Queues: Operations and applications,
4. Circular Queues: Operations and applications, Concept of Double ended Queue and Priority Queues
5. Linked Lists: Operations and applications of Linear linked list, Circular linked list, Doubly linked list.
6. Trees: Binary Trees, Binary Tree Representations, Operations (insert/delete), Tree Traversal Techniques, Threaded
7. Binary Tree. Applications of Trees, Search Trees: AVL Tree (single and double rotations), B-Tree
8. Graphs: Representation (Matrix/Adjacency) and Traversal (Depth First Search/Breadth First Search), Spanning Trees, Minimal Spanning Tree (Prim's and Kruskal's algorithm), Shortest Paths and All Pair Shortest Path, Dijkstra's, Floyd-Warshall Algorithms.
9. Hash Table: Hash Function, Collision and its Resolution, Separate Chaining, Open Addressing (linear probing, quadratic probing, double hashing), Rehashing, Extendible Hashing
10. Searching Techniques: Linear Search, Binary Search (array/ binary tree) methods.
11. Sorting Techniques: General Background, Sorting Techniques: Bubble Sort, Insertion Sort, Selection Sort, Quick sort, Merge sort, Heap sort and Radix Sort

Reference Books:

- i. ADTs, Data Structures, and Problem Solving with C++, Author: Larry R Nyhoff, ISBN: 9788131764701, Pearson Education
- ii. Data Structures and Algorithms in C++, 2nd Edition Michael T. Goodrich, Roberto Tamassia, David M. Mount, Wiley
- iii. Algorithms and Data Structures: The Basic Toolbox, Mehlhorn, Kurt, Sanders, Peter, Springer, ISBN: 9783540779773
- iv. Data Structures Using C and C++ 2 Edition, (Paperback), Yedidyah Langsam, Aaron M. Tenenbaum, Moshe J. Augenstein, PHI Learning ISBN: 9788120311770

MT204: Programming with C++

1. Review of C Language: functions, Pointers, Structures, Array, file handling
2. Introduction: What is object-oriented programming? Why Do We Need Object-Oriented Programming characteristics of Object-Oriented Languages, C++ and C
3. C++ Programming Basics: Output Using cout Directives, Input with cin, Type bool, The setw Manipulator, Type Conversions.
4. Functions: Returning values From Functions, Reference Arguments, Overloaded Function, Inline Function, Default Arguments, Returning by Reference.
5. Object and Classes: Making sense of core object concepts (Encapsulation Abstraction, Polymorphism, Classes, Messages Association, Interfaces) Implementation of Class in C++, C++ Objects as Physical Object, C++ Object as Data Types Constructor, Object as Function Arguments, The Default Copy Constructor, Returning Object from Function, Structures and Classes, Classes Objects and Memory Static Class Data, Const Data and Classes.
6. Arrays and String: Arrays Fundamentals, Arrays as Class Member Data. Arrays of Object, String, The Standard C++ String Class.

7. Operator Overloading: Overloading Unary Operators, Overloading Binary Operators, Data Conversion, Pitfalls of Operators, Overloading and Conversion, Keywords Explicit and Mutable.
8. Inheritance: Concept of Inheritance, Derived Class And Base Class, Derived Class Constructors, Overriding Member Function, Inheritance In The English Distance Class, Class Hierarchies, Inheritance And Graphics Shapes, Public And Private Inheritance, Levels Of Inheritance, Multiple Inheritance, Ambiguity In Multiply Inheritance, Aggregation: Classes Within Classes, Inheritance And program Development.
9. Pointer: Addresses And pointer, The Address-Of Operator &, Pointer And Arrays, Pointer And Faction, Pointer AndC- Types String, Memory Management: New And Delete, Pointers To Objects, Debugging pointers.
10. Virtual Function: Virtual Function, Friend Function, Static Function, Assignment and Copy Initialization, This Pointer, Dynamic Type Information.
11. Streams and Files: Streams Classes, Stream Errors. Disk File I/O with Streams, File Pointers, Error Handling In File, I/O File I/O With Member Function, Overloading the Extraction And Insertion Operator, Memory As A Stream Object, Command line Arguments, and Printer Output.
12. Templates: Generic programming, template functions, defining a class template, using a template class, using template with family of classes, template versatility, template specialization, inheritance.
13. Exception Handling: The exception mechanism, exception versatility, multiple try blocks, exception and classes, exception and inheritance, the exception class.

Reference Books:

- i. C++ Primer Plus, Stephen Prata, Pearson, ISBN 9788131786987,
- ii. Programming in C++, Ashok Kamthane, Pearson, ISBN 9788131791448
- iii. Introduction to Programming with C++, Y. Daniel Liang, Pearson, ISBN 9788131760659 ,
- iv. The C++ Programming Language , B. Stroustrup Addison-Wesley ISBN 978-0321563842

MT 205: Operating Systems

1. Basics: Operating System Functionalities, Types of Operating Systems, Computer Architecture support to Operating Systems
2. Understanding the System Calls
3. Process Management: Process Scheduling - Uniprocessor scheduling algorithms, Multiprocessor and Real-time scheduling algorithms, Process Synchronization - Peterson's Solution, Bakery Algorithm, Hardware Support to Process Synchronization, Semaphores, Critical Regions, Monitors - Deadlock prevention, deadlock avoidance and Deadlock Detection and Recovery - Bankers Algorithm, Threads

4. Memory Management: Segmentation and space allocation, Basics of linking and loading, Demand Paging, Page replacement algorithms, Analysis of page allocation policies - Working Set.
5. File Systems: Contiguous, Sequential and Indexed Allocation, File system interface, File System implementation.
6. I/O System: Disk Scheduling, Device drivers - block and character devices, streams, Character and Block device switch tables.
7. Protection and Security - Accessibility and Capability Lists.
8. Case Study of Unix/Linux Operating System with reference to Process Management, Memory Management and File Management.

Reference Books:

- i. Operating System Concepts 8 Edition (Paperback), Peter B. Galvin, Abraham Silberschatz, Gerg Gagne, Wiley, ISBN:9788126520510
- ii. Operating Systems, Nutt, , Pearson Education ISBN:9788131723593
- iii. Operating Systems, William Stallings, Pearson, ISBN:9788131725283,
- iv. Operating Systems, Haldar & Aravind, Pearson , ISBN: 9788131715482,
- v. Understanding the Linux Kernel 3rd Edition (Paperback), Daniel P Bovet, Marco Cesati, O'Reilly, ISBN: 9788184040838
- vi. The Design of the UNIX Operating System (Paperback), Maurice J. Bach, PHI Learning, ISBN-9788120305168
- vii. UNIX System Programming Using C++ (Paperback), Terrence Chan, PHI Learning, ISBN:9788120314689