University of Pune
Department of Mathematics
Syllabus for M.Tech.
.(Industrial Mathematics with Computer Applications)
(To be implemented from Academic year 2014-2015)

Course Structure –

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

No. 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 5 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. Each semester is of 5 courses and 25 credits (This is not applicable for Industrial training in 6^{th} semester of M.Tech.).

ATKT Rules –

- Each regular student will have to appear for all the 25 credits of the respective semester.
- Student who wishes to take admission to the second year M.Tech. should have obtained at least 25 credits out of 50 credits of the First year M.Tech.

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 VI^{th} semester (Full Time Industrial Training / Institutional project) will be carried out as follows:
    1. A student will inform the department about the joining date of the above mentioned training.
    2. 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.
    3. 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.
    1. Home Assignment(s)
    2. Seminar/Presentation by the student
    3. Laboratory assignment

4. Group Discussions
5. Research Paper Review
6. Technology Demonstration
7. 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

1. In order to pass the M.Tech. (Industrial Mathematics with Computer Applications) Course a student has to obtain 150 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.
2. 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.
3. The policies and procedures determined by University will be followed for the conduct of examinations and declaration of the result of a candidate

M.Tech. First Year

Semester: I (Minimum Credit: 25, Core course is compulsory)

	Course	Title of the course	Hours/ Week	Credit
Core	MT-101	Algebra	5	5
Core	MT-102	Linear Algebra	5	5
Core	MT-103	Discrete Mathematics	5	5
Core	MT-104	Computer Organization	5	5
Core	MT-105	Numerical recipes in C	5	5

Semester: II (Minimum Credit: 25, Core course is compulsory. Extra Course is an Audit Course)

	Course	Title of the course	Hours/ Week	Credit
Core	MT-201	Foundations of Analysis	5	5
Core	MT-202	Differential Equations	5	5
Core	MT-203	Data Structures	5	5
Core	MT-204	Programming with C++	5	5
Core	MT-205	Operating Systems	5	5
Extra	MT-206	Soft Skills	Audit course which is compulsory	

M.Tech. Second Year

Semester: 3 (Minimum Credit: 25, Core course is compulsory)

	Course	Title of the course	Hours/ Week	Credit
Core	MT-301	Complex Analysis	5	5
Core	MT-302	Database management systems	5	5
Core	MT-303	Theory of Computer Science	5	5
Core	MT-304	Design and Analysis of Algorithms	5	5
Core	MT-305	Computer Graphics	5	5

M.Tech. Second Year

Semester: 4 (Minimum Credit: 25, Maximum Credits: 35, Core courses are compulsory)

From elective courses student can select one or Two courses.

	Course	Title of the Course	Hours/ Week	Credit
Core	MT-401	Operations Research using software	5	5
Core	MT-402	Rings and Fields	5	5
Core	MT-403	Software Engineering	5	5
Core	MT-404	Computer Networks	5	5
Core	MT-405	Programming with JAVA	5	5
Elective	MT-406	Computational Geometry	5	5
Elective	MT-407	Data Mining	5	5
Elective	MT-408	Artificial Intelligence	5	5
Elective	MT-409	Cryptography	5	5
Elective	MT-410	Image Processing	5	5

2M.Tech. Third Year

Semester: 5(Minimum Credit: 25, Maximum Credits: 35, Core courses are compulsory)

From elective s student can select three courses for Minimum credit and Five for Maximum Credit

	Course	Title of the course	Hours/ Week	Credit
Core	MT-501	Coding Theory	5	5
Core	MT-502	Object oriented modeling and design	5	5
Elective	MT-503	Programming with Advanced Java	5	5
Elective	MT-504	Programming with DOT NET	5	5
Elective	MT-505	Programming using mobile technologies	5	5
Elective	MT-506	Compiler construction	5	5
Elective	MT-507	Integral Transforms	5	5
Elective	MT-508	Financial Mathematics	5	5
Elective	MT-509	Advanced Algorithm	5	5
Elective	MT-510	Managerial Techniques using Operations Research	5	5
Elective	MT-511	Mathematical Modeling and Simulation	5	5
Elective	MT-512	Fuzzy Set Theory	5	5
Elective	MT-513	Cloud Computing	5	5

Semester: 6 (Minimum Credit : 15, Maximum Credits: 25 Core course is compulsory)

Subject	Paper	Title of Paper	Hours/ Week	Credit
Core	MT-601	Industrial Training /Institutional project	--	15
Elective	MT-602	A student can select at most two electives from the list of electives provided in semester IV and semester V.	5	5
Elective	MT-603		5	5

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.

Prescribed Book:

• Joseph A. Gallian, Contemporary Abstract Algebra (Fourth Ed.), Narosa, 1999. (Part 2 : Groups)

Reference Book:

• P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra (Second Ed.), Cambridge Univ. Press (Indian Ed. 1995).

• I. S. Luthar and I. B. S. Passi, Algebra-Vol. 1: Groups, Narosa, New Delhi, 1996.

MT 102 Linear Algebra

Gaussian elimination, echelon forms, properties of determinants, complexity of calculating determinants.

Vector spaces, subspaces, linear independence, basis, dimension, linear transformations.

Orthogonal vectors and subspaces, orthogonal matrices, projections, least squares, orthogonal basis Gram Schmidt.

Eigenvalues and eigenvectors, diagonalisation, Jordan form, difference equations, A^k, Differential equations, and e^{At}.

Positive definite matrices, maxima, minima, saddle points, singular value decomposition, matrix norms, condition numbers, computation of eigenvalues, iterative methods for Ax=b.

Prescribed books :

1. Linear Algebra and its applications, by Gilbert Strang.
2. 2. 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, Labeled 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, Odinary and Exponential Generating unctions, Recurrence Relation, Methods of Solution of Recurrence Relatiion , Substitution Method, Characteristic Method, Generating Function Method, Principle of Inclusion and Exclusion.

Prescribed Books:

• Kolman, Busby, Ross, Discrete Mathematical Structures,Fifth Edition (Pearson Education).

• Purna Chandra Biswal, Discrete Mathematics and Graph Theory, Second Edition (PHI.).

Reference Book:

- Alan Tucker, Applied Combinatorics, Forth Edition (John Willey).

MT 104 Computer Organization

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

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

Combinational Circuits: Introduction, Multiplexers and Demultiplexers, Decoders and Encoders, Comparators, Adders, Programmable Logic Devices, Arithmetic and Logic Units

Sequential Logic Circuits: Introduction, Clock Signal, Latches, Flip-Flops, Example Sequential Circuits, Sequential Circuit Design

Processor Organization and Performance: Introduction, Number of Addresses, Flow of Control, Instruction Set Design Issues, Microprogrammed Control, Performance

RISC and CISC processor architectures

CISC (case study of Intel Processors)

RISC (case study of ARM processors)

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

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

Input / Output Organization Introduction, Accessing I/O Devices, I/O Data Transfer, Error Detection and Correction, System Buses and their architecture.

Interrupts: Introduction, taxonomy of Interrupts, Hardware Interrupts, Software Interrupts, and Exceptions.

References:

1.Computer System Architecture 3 Edition (Paperback), M. Morris Mano, Pearson Education, ISBN-9788131700709

2.Computer Architecture and Organization : An Integrated Approach (Paperback), Miles Murdocca, Vincent Heuring, Wiley, ISBN-9788126511983

3.Digital Logic and Computer Design 1st Edition (Paperback), M. Morris Mano, Pearson Education, ISBN-9788177584097

4.Computer Organization and Design : The Hardware/Software Interface 4 Edition (Paperback), David A. Patterson, John L. Hennessy, , Morgan Kaufmann Publishers, ISBN-9788131222744

5.Computer Organization, Design and Architecture,Shiva 0004 Edition (Hardcover), Sajjan G. Shiva,CRC Press, ISBN-9780849304163

MIM 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, eclarations, 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.

Prescribed Books:

1. Byron S, Gottfried, Programming with C, Schaum'sOutline series.
2. W. H. Press, S. A. Teukolsky et. al., Numerical recipies in C, The art of Scientific Computing.
3. Yashwant Kanetkar, Let us C, BPB Publications.

Reference Book:

Brian W, Kernighan, Dennis M, Ritchie, The C Programming Language, Prentice Hall Publication.

MIM 201 : Foundations of Analysis

1. A Taste of Topology: Metric space concepts, Compactness, Connectedness, Coverings, Cantor sets.

2. Functions of a Real Variable: Differentiation, Reimann integration, Series.

3. Function Spaces: Uniform convergence and C0[a, b], Power series, Compactness and equicontinuity in C0.

4. Multivariate Calculus: Derivatives, Higher derivatives, Smooothness classses, Implicit and inverse functions.

5. Lebesgue Theory: Outer measure, Measurability, Regularity, Lebesgue integrals.

Prescribed Book:

• 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.)

Reference Books:

• N. L. Carothers, Real analysis, Cambridge University Press India, 1999.

• 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.

Prescribed Book:

• E. A. Coddington, An Introduction to Ordinary Differential Equations (Prentice- Hall).

Reference Book:

G. F. Simmons and S. G. Krantz, Differential Equations (Tata McGraw-Hill).

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MT-203: Data Structures

Introduction to Data Structures Abstract Data Types, review of arrays and strings, structures and pointers concepts in C/C++, recursion and its efficiency.

Stacks: Operations and applications (Infix, Postfix and prefix expression handling),

Queues: Operations and applications,

Circular Queues: Operations and applications, Concept of Double ended Queue and Priority Queues

Linked Lists: Operations and applications of Linear linked list, Circular linked list, Doubly linked list.

Trees: Binary Trees, Binary Tree Representations, Operations (insert/delete), Tree Traversal Techniques, Threaded Binary Tree. Applications of Trees, Search Trees: AVL Tree (single and double rotations), B-Trees

Graphs: Representation (Matrix/Adjacency) and Traversal (Depth First Search/Breadth First Search), Spanning Trees, Minimal Spanning Tree (Prim's and Kruskals's algoritm), Shortest Paths and All Pair Shortest Path, Dijkstra's, Floyd-Warshall Algorithms.

Hash Table: Hash Table: Hash Function, Collision and its Resolution, Separate Chaining, Open Addressing (linear probing, quadratic probing, double hashing), Rehashing, Extendible Hashing

Searching Techniques: Linear Search, Binary Search (array/ binary tree) methods.

Sorting Techniques: General Background, Sorting Techniques: Bubble Sort, Insertion Sort, Selection Sort, Quick sort, Merge sort, Heap sort and Radix Sort

References:

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

MT-204: Programming with C++

Review of C Language: functions, Pointers, Structures, Array, file handling

Introduction: What is object-oriented programming? Why Do We Need Object-Oriented Programming characteristics of Object-Oriented Languages. C++ and C

C++ Programming Basics: Output Using cout, Directives. Input With cin. Type bool. The setw Manipulator. Type Conversions.

Functions: Returning values From Factions. Reference Arguments, Overloaded Function, Inline Function. Default Arguments. Returning by Reference.

Object and Classes:

Making sense of core object concepts (Encapsulation Abstraction, Polymorphism, Classes,

Massages 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. Const and Classes.

Arrays and String: Arrays Fundamentals. Arrays as Class Member Data. Arrays of Object. String. The Standard C++ String Class.

Operator Overloading: Overloading Unary Operators. Overloading. Binary Operators. Data Conversion. Pitfalls of Operators Overloading and Conversion. Keywords Explicit and Mutable

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.

Pointer: Addresses And pointer, The Address-Of Operator &, Pointer And Arrays, Pointer And Faction, Pointer And C- Types String, Memory Management: New And Delete, Pointers To Objects, Debugging pointers.

Virtual Function: Virtual Function, Friend Function, Static Function, Assignment and Copy Initialization, This Pointer, Dynamic Type Information.

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.

Templates : Generic programming, template functions, defining a class template, using a template class, using template with family of classes, template versality, template specilization, inheritance.

Exception Handling : Exception, the exception mechanism, exception versality, multiple try blocks, exception and classes, exception and inheritance, the exception class.

References:

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

MT-205: Operating Systems

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

References:

- Operating System Concepts 8 Edition (Paperback), Peter B. Galvin, Abraham Silberschatz, Gerg Gagne,Wiley,ISBN:9788126520510

- Operating Systems, Nutt, , Pearson Education ISBN:9788131723593
- Operating Systems, William Stallings, Pearson, ISBN:9788131725283,
- Operating Systems, Haldar & Aravind, Pearson , ISBN: 9788131715482,
- Understanding the Linux Kernel 3rd Edition (Paperback), Daniel P Bovet, Marco Cesati, O'Reilly, ISBN: 9788184040838
- The Design of the UNIX Operating System (Paperback), Maurice J. Bach, PHI Learning, ISBN-9788120305168
- UNIX System Programming Using C++ (Paperback), Terrence Chan, PHI Learning, ISBN:9788120314689