**M. C. E. Society's**
**Abeda Inamdar Senior College**
Of Arts, Science and Commerce, Camp, Pune-1 (Autonomous)
Affiliated to Savitribai Phule Pune UniversityNAAC accredited
'A' Grade

**Two Year M.Sc. Degree Program in Mathematics**
**(Faculty of Science & Technology)**

# Syllabus for

## M.Sc.-I
## Industrial Mathematics with Computer Applications
## (IMCA)

**Choice Based Credit System Syllabus**
**To be implemented from the academic year 2024-2025**

**Aims and Objectives of the Course**

| Sr. No. | Objectives |
|---|---|
| 1. | To provide students with an environment that is conducive to their academic development and overall progress |
| 2. | To impart students the mathematical knowledge and necessary skills so that they develop a better appreciation and understanding of modern mathematics and current technical advancements. |
| 3. | To motivate students to explore various opportunities in the field of academics and industrial sector |
| 4. | To develop competence among the students so that they are able to apply mathematics and technical knowledge in various spheres of life |

**Expected Course Specific Learning Outcome**

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|---|---|
| 1 | A competent student will be able to join Industry for a job. |
| 2 | A student will be able to demonstrate mastery of subject material, as exhibited by quantitative and qualitative performance in core and elective courses, and as reflected in the grade sheet. |
| 3 | A student with an interest in the teaching profession will firmly communicate, mathematical and technical components with context and interdisciplinary importance in written and oral form, as a persistent mathematics student |
| 4 | A student with an inclination towards applicable mathematics will be able to explore and avail the opportunities in academia as well as industrial sectors. |
| 5 | A student will be able to appear for NET/SET/PET/ equivalent exams in mathematical sciences, computer science. Further, all opportunities such as teaching/research/government jobs/ private sector jobs which are available for M.Sc. Mathematics students will also be available for M.Sc. (IMCA) students. |

**Structure of M.Sc-I Industrial Mathematics with Computer Applications Course**

| Sr. No. | Major Mandatory | | Continuous Internal Evaluation (CIE) (Internal Marks) | End Semester Exam (External Marks) | Total Marks | Credits |
|---|---|---|---|---|---|---|
| | **Semester-I** | **Semester-II** | | | | |
| 1. | 23SMIMT11MM: Applied Linear Algebra | 23SMIMT21MM: Mathematical Analysis | 50 | 50 | 100 | 04 |
| 2. | 23SMIMT12MM: Abstract Algebra | 23SMIMT22MM: Calculus for Computer Science | 50 | 50 | 100 | 04 |
| 3. | 23SMIMT13MM: C programming | 23SMIMT23MM: C++- Programming | 25 | 25 | 50 | 02 |
| 4. | 23SMIMT14MM: Database Management | 23SMIMT24MM: Web Development | 25 | 25 | 50 | 02 |
| 5. | 23SMIMT15MM: Practical based on C Programming and Database Management | 23SMIMT25MM: Practical based on C++ and Web Development | 25 | 25 | 50 | 02 |
| 6 | 23SMIMT11RM: Research Methodology | | | | 100 | 04 |
| 5. | | 23SMIMT21OJ: OJT/FP | | | 100 | 04 |
| **Major Electives (Any One)** | | | | | | |
| 6. | 23SMIMT11MEA: Mathematical Foundation for Computer Science | 23SMIMT21MEA: Coding Theory | 50 | 50 | 100 | 04 |
| 7. | 23SMIMT11MEB: Theoretical Computer Science | 23SMIMT21MEB: Numerical Analysis | 50 | 50 | 100 | 04 |
| 8. | 23SMIMT11MEC: course from Swayam /NPTEL / E-Pathashala etc. | 23SMIMT21MEC: course from Swayam /NPTEL / E-Pathashala etc. | | | 100 | 04 |

**Structure of M.Sc-II Industrial Mathematics with Computer Applications Course**

| Sr. No. | Major Mandatory | | Continuous Internal Evaluation (CIE) (Internal Marks) | End Semester Exam (External Marks) | Total Marks | Credits |
|---|---|---|---|---|---|---|
| | Semester-III | Semester-IV | | | | |
| 1. | 23SMIMT31MM: Programming with Java | 23SMIMT41MM: Applied Geometry for Computer Graphics | 50 | 50 | 100 | 04 |
| 2. | 23SMIMT32MM: Complex Analysis | | 50 | 50 | 100 | 04 |
| | | 23SMIMT42MM: Android (Practical) | 25 | 25 | 50 | 02 |
| | | 23SMIMT43MM: Data Structure (Practical) | 25 | 25 | 50 | 02 |
| 3. | 23SMIMT33TMM: Programming with Python (Theory) | 23SMIMT44TMM: Introduction to Data Science (Theory) | 25 | 25 | 50 | 02 |
| 4. | 23SMIMT33PMM: Programming with Python (Practical) | 23SMIMT44PMM: Introduction to Data Science (Practical) | 25 | 25 | 50 | 02 |
| 5. | 23SMIMT34MM: Fourier Series and Boundary Value | - | 25 | 25 | 50 | 02 |

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| | Problems | | | | | |
| 6. | 23SMIMT31RP: Research Project | - | | | 100 | 04 |
| | - | 23SMIMT41RP: Research Project | | | 150 | 06 |
| **Major Electives (Any One )** | | | | | | |
| 7. | 23SMIMT31MEA: Probability and Stochastic Process | 23SMIMT41MEA: Optimization Techniques | 50 | 50 | 100 | 04 |
| 8. | 23SMIMT31MEB: Artificial Intelligence | 23SMIMT41MEB: Statistical Inference | 50 | 50 | 100 | 04 |
| 9. | 23SMIMT31MEC: course from Swayam /NPTEL / E-Pathashala etc. | 23SMIMT41MEC: course from Swayam /NPTEL / E-Pathashala etc. | | | 100 | 04 |

**Syllabus:**

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|---|---|
| **Course/ Paper Title** | **Applied Linear Algebra** |
| **Course Code** | **23SMIMT11MM** |
| **Semester** | **I** |
| **No. of Credits** | **04** |

| Unit No | Title with Contents | No. of Lectures |
|---|---|---|
| **Unit I** | **Vector Spaces:** | **10** |
| | Vector spaces, subspaces, linear independence, basis and dimension, linear transformations, quotient Spaces, direct sum, the matrix of linear transformation. | |
| **Unit II** | **Canonical Forms** | **10** |
| | Eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalizability, Jordan form (without proof). | |
| **Unit III** | **Orthogonality** | **10** |
| | Orthogonal vectors and subspaces, cosines and projection onto lines, projections and least square methods, orthogonal basses and Gram-Schmidt process. | |
| **Unit IV** | **Positive Definite Matrices** | **10** |
| | Minima, maxima and saddle point, tests for positive definiteness, singular value decomposition, principal component analysis, quadratic forms. | |
| **Unit V** | **Applications** | **10** |
| | Image processing, **c**omputer graphics, pattern recognition, Google page rank algorithm. | |
| **Unit VI** | **Numerical Computations** | **10** |
| | Numerical computations of determinants, solutions of linear systems, eigenvalues, eigenvectors, diagonalizability using mathematical softwares like Scilab/Matlab. | |

**Reference Books:**


1. Linear Algebra by Vivek Sahai, Vikas Bist
2. Linear Algebra and its applications, 5th Edition by Gilbert Strang.
3. Linear Algebra, 5th Edition by Stephen Friedberg, Arnold Insel, Lawrence Spence
4. Linear Algebra and Its Applications, 5th Edition by David Lay, Steven Lay, Judi McDonald
5. Linear Algebra Done Right, 3rd Edition by Sheldon Axler

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|---|---|
| **Course/ Paper Title** | **Abstract Algebra** |
| **Course Code** | **23SMIMT12MM** |
| **Semester** | **I** |
| **No. of Credits** | **04** |

| Unit No | Title with Contents | No. of Lectures |
|---|---|---|
| **Unit I** | **Introduction to Groups** | **06** |
| | Symmetries of a Square, The Dihedral Groups, Definition and Examples of Groups, Elementary Properties of Groups. | |
| **Unit II** | **Subgroups and Cyclic Groups** | **10** |
| | Terminology and Notation, Subgroup Tests, Examples ofSubgroups, Properties of Cyclic Groups, Classification of Subgroups of Cyclic Groups, Properties of Cosets, Lagrange's Theorem and Consequences. | |
| **Unit III** | **Permutation Groups:** | **10** |
| | 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. | |
| **Unit IV** | **Group Homomorphism and Isomorphism** | **10** |
| | Definition and Examples of Homomorphism, Properties of Homomorphism. Definition and Examples of Isomorphism, Properties ofIsomorphism, Cayley's Theorem, The First Isomorphism Theorem, Automorphism | |
| **Unit V** | **External Direct Products** | **10** |
| | Definition and Examples, Properties of External Direct Products, The Group of Units Modulo n as an External Direct Product, Applications. | |
| **Unit VI** | **Normal Subgroups and Factor Groups** | **08** |
| | Normal Subgroups, Factor Groups, Applications of Factor Groups, | |

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| | Internal Direct Products. | |
| **Unit VII** | **Fundamental Theorem of Finite Abelian Groups** | **06** |
| | The Fundamental Theorem, The Isomorphism Classes of Abelian Groups. | |

**Reference Books:**


1. Joseph A. Gallian, Contemporary Abstract Algebra (Fourth Ed.), Narosa, 1999.
2. D. S. Dummit and R. M. Foote, Abstract Algebra (Third Edition), Wiley, 2011.
3. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra (Second Ed.), Cambridge Univ. Press (Indian Ed. 1995).
4. I. S. Luthar and I. B. S. Passi, Algebra-Vol. 1: Groups, Narosa, New Delhi, 19964.


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|---|---|
| **Course/ Paper Title** | **C Programming** |
| **Course Code** | **23SMIMT13MM** |
| **Semester** | **I** |
| **No. of Credits** | **02** |

| Unit No. | Title with Contents | No. of Lectures |
|---|---|---|
| **Unit I** | **Introduction to Programming** | **1** |
| | Program and Programming, Programming Languages, Types of Software, Operating Systems, Basic Linux Commands and vi Editor, Compiler, Interpreter, Loader and Linker, Introduction to algorithms, flow charts, Background of internal working of compilers | |
| **Unit II** | **Basics of C** | **2** |
| | History and Features of C, Importance of C, Backslash Characters, Character set, Constants, Format Specifiers, Identifiers, Keywords, Variables, Data Types, Comments, const Qualifier, The Structure of a C Program, Building an Executable Version of a C Program, Debugging a C Program, Programming Examples | |
| **Unit III** | **Applications of C Programming** | **1** |
| | Demonstration of an application developed using C<br>Note: This unit will not be considered for an assessment of students | |

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| **Unit IV** | **Control Statements** | **2** |
| | Decision Making Statements: if, if-else, switch Loop Control Structures: while, do. while, for<br>Keywords- break and continue, exit () Function, return Statement, Programming Examples Approximation to solutions, and uniqueness of solutions. | |
| **Unit V** | **Input and Output** | **2** |
| | Unformatted I/O, Character I/O, String I/O, Formatted I/O, Programming Examples | |
| **Unit VI** | **Functions** | **3** |
| | Concept, Usage of a Function, Advantages, Function Prototype, Function example, Types of Function, Call by Value and Call by Address, Recursion, Library Functions, Local variable, Global Variable, Storage classes (automatic, static, register, external), Programming Examples. | |
| **Unit VII** | **Array** | **3** |
| | Array Declaration, Initialization, Types of Arrays (1-D, 2-D and Multidimensional), Passing Arrays to Functions, Programming Examples. | |
| **Unit VIII** | **Pointers** | **3** |
| | Pointer Declaration and Initialization, Dereferencing Pointers, void Pointer, Pointer Arithmetic, Pointer to Pointer, Arrays and Pointers, Functions and Pointers, Passing Pointers to Function, Function Returning Pointer, Pointer to Function, Dynamic Memory Allocation, Programming Examples. | |
| **Unit IX** | **String Handling** | **4** |
| | Declaration and Initialization, Reading and Writing Strings, Standard String Library, Functions, Array of Pointers to String, Command Line Arguments, Programming Examples. | |
| **Unit X** | **Structures and Unions** | **4** |
| | Overview of Structures, Defining and Using a Structure, typedef Keyword, Nested Structures, Passing Structure to Function, Structure and Pointer, Union, Difference between Structure and | |

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| | Union, Programming Examples. | |
| **Unit XI** | **Pre-Processor Directives** | **4** |
| | Pre-Processor Directives, #define Macro, Conditional Compilation, Pre- defined Macros, #include and Header Files, Programming Examples. | |
| **Unit XII** | **File Handling** | **5** |
| | What is a Stream? Opening and Closing of Files, File Opening Modes, Writing and Reading in Text Format, Writing and Reading in Binary Format, Programming Examples. | |

**Reference Books:**


1. Kernighan Brian W., Ritchie Dennis M., The C Programming Language, PHI Learning Pvt. Ltd., 2nd Edition, 2010
2. Schildt Herbert, C: The Complete Reference, Tata McGraw Hill, 4th Edition, 2006
3. Kanetkar Yashavant, Pointers in C, BPB Publications, 4th Edition, 2013
4. Kanetkar Yashavant, Test your C Skills, BPB Publications, Rev. Edition, 2008


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|---|---|
| **Course/ Paper Title** | **Database Management Systems** |
| **Course Code** | **23SMIMT14MM** |
| **Semester** | **I** |
| **No. of Credits** | **02** |

| Unit No. | Title with Contents | No. of Lectures |
|---|---|---|
| **Unit I** | **Introduction to data and databases** | **4** |
| | Data – Introduction / Concept, introduction to data structures, Introduction to databases, Significance of Database, System Applications, Data Independence, Entities and their Attributes, Relationship and Relationship Types, E-R Diagram, Data types, Creating tables (without keys) | |
| **Unit II** | **Overview of RDBMS (PostgreSQL)** | **4** |

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|---|---|---|
| | Relational Database Management System, RDBMS Properties, Maintaining Integrity and Defining Data Integrity, Integrity Rules and Integrity Constraints, Relational Integrity Rules, Creating tables (with keys) | |
| **Unit III** | **SQL** | **4** |
| | Types of SQL, DDL, DML, Basic queries in SQL Single table, Deletion-Insertion and Update in SQL, Simple queries (with insert, delete, and update), Multi table Retrievals, Nested queries (with foreign key and using multi tables), Aggregate-Functions, Joins, GROUPBY - HAVING clause, Nested Sub queries | |
| **Unit IV** | **Views and Stored Functions** | **4** |
| | View definition, how to write view and its execution, Function definition, how to write function and its execution, Solving some problems with function | |
| **Unit V** | **Cursors** | **4** |
| | Cursor definition, how to write cursor and its execution, Solving some problems with cursor, Introduction to triggers and some demo examples | |
| **Unit VI** | **NoSQL** | **5** |
| | Introduction, Why NoSQL? RDBMS Vs NoSQL, Features of NoSQL, Types:<br>Key-value Pair Based, Column-oriented, Graphs based, Document-oriented, ACID and BASE for reliable database transactions, CAP theorem | |
| **Unit VII** | **Introduction to MongoDB** | **5** |
| | Basics, Installation and Set Up, CRUD operations<br>Working with online database (Demonstration) | |

**Reference Books:**


1. Henry F. Korth, Abraham Silberschatz, S. Sudarshan Database System Concepts, ISBN:9780071289597, Tata McGraw-Hill Education
2. Korry Douglas, PostgreSQL, ISBN:9780672327568
3. John Worsley, Joshua Drake Practical PostgreSQL (B/CD), ISBN: 9788173663925Shroff / O'reilly

4. Joshua D. Drake, John C Worsley Practical Postgresql, O'Reilly

5. Richard Stones, Neil Matthew Beginning Databases with PostgreSQL, From Noviceto Professional, 2nd Edition

**Websites:**

1. https://www.postgresql.org/docs/current/
2. https://www.mongodb.com/docs/atlas/

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|---|---|
| **Course/ Paper Title** | **Research Methodology** |
| **Course Code** | **23SMIMT11RM** |
| **Semester** | **I** |
| **No. of Credits** | **4** |

**Syllabus**

| Unit No | Title with Contents | No. of Lectures |
|---|---|---|
| **Unit I** | **Scientific Research and Literature Survey** | **10** |
| | Finding and solving research problems, Role of a supervisor, Survey of a research topic. Publishing a paper. Reviewing a paper., Funding agencies, Research grant proposal writing, Copyright issues, Ethics and plagiarism. MathSciNet, ZMATH, Scopus, ISI Web of Science, Impact factor, h-index. Google Scholar, ORCID, JStor, Online and open access journals. | |
| **Unit II** | **Introduction to LaTeX** | **02** |
| | Definition and application of LaTeX, Preparationand Compilation of LaTeX input file.<br>LaTeX Syntax and Keyboard Characters in LaTeX | |
| **Unit III** | **Formatting Words, Lines, and Paragraphs** | **04** |
| | Text and Math Mode Fonts, Emphasized and Colored Fonts. Labeling and Referring Numbered Items, Texts Alignment and Quoted text. New | |

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|---|---|---|
| | Lines and Paragraphs. | |
| **Unit IV** | **Listing and Table Preparation** | **06** |
| | Listing Texts, Table Through the tabular Environment and tabularx Enviroment, Vertical Positioning of Tables, Sideways (Rotated)Texts in Tables, Merging Rows and Columns of Tables. | |
| **Unit V** | **Equation Writing** | **03** |
| | Basic Mathematical Notations and Delimiters. Mathematical Operators, Mathematical Expression, in Text- mode,Simple Equations and Array of Equations. | |
| **Unit VI** | **Figure Insertion and Figure Drawing** | **03** |
| | Commands and Environment for Inserting Figures, tikz package for drawing figures. | |
| **Unit VII** | **Presentation Using Beamer** | **04** |
| | Frames and Sectional Units in Presentation, Presentation Structure., Appearance of a Presentation(Beamer Themes). | |
| **Unit VIII** | **Getting Started with SageMath** | **03** |
| | Introduction and Installation of SageMath, Exploring integers, solving equations in SageMath. 2D and 3D plotting in SageMath. | |
| **Unit IX** | **Calculus with SageMath** | **08** |
| | Calculus of one variable with SageMath, Applications of derivatives, Applications of Integrals. Partial Derivatives and gradients, jacobians. Local maximum-minimum, Application of local maximum and minimum | |
| **Unit X** | **Linear Algebra with SageMath** | **07** |

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| | RREF and Solving system of linear Equations, Vector spaces in SageMath, Linear Transformations with SageMath, Eigenvalues and Eigenvectors with SageMath, Inner Product Spaces in SageMath, Gram-Schmidt Process. | |
| **Unit XI** | **Numerical Analysis with SageMath** | **10** |
| | QR- Factorization, Singular Value Decomposition (SVD), Numerical Solution of algebraic equations, Numerical Solutions of system linear equations, Interpolations, Numerical Integration. | |

**Reference**: **LaTeX**

1. Dilip Datta, LaTeX in 24 Hours, A Practical Guide for Scientific Writing, SpringerUnit

2. Zofia Walczak, Graphics in LATEX using TikZ.

**Reference Books: SageMath**

1. Mathematical Computation with Sage by Paul Zimmermann available from on http://www.sagemath.org.

2. An Introduction to SAGE Programming: With Applications to SAGE Interacts for Numerical Methods by Razvan A Mezei, Springer.

3. Sage for Undergraduates, Gregory V. Bard.

| **Course/ Paper Title** | **Mathematical Foundation for Computer Science** |
|---|---|
| **Course Code** | **23SMIMT11MEA** |
| **Semester** | **I** |
| **No. of Credits** | **04** |

| Unit No | Title with Contents | No. of Lectures |
|---|---|---|
| | **A] Graph Theory** | |
| **Unit I** | **Topics in Graph Theory** | **15** |
| | Graphs; Graphs as Models; Matrices and Isomorphism; Decomposition and Special Graphs; Degree of a vertex; Counting and Bijections.<br>Paths, Cycles, Trails: Connection in Graphs; BipartiteGraphs; Eulerian Circuits; Hamiltonian Cycles.<br>Directed Graphs: Definition and Examples; Vertex Degrees; Eulerian Digraphs. | |
| **Unit II** | **Trees** | **12** |
| | Trees: Properties of Trees; Distance in Trees and Graphs.<br>Enumeration of Trees: Spanning Trees in Graphs; Minimum Spanning Trees; Shortest Paths; Connectivity;Edge Connectivity.<br>Trees in Computer Science. | |
| **Unit III** | **Matchings** | **3** |
| | Maximum Matchings; Hall's Matching Condition. | |
| | **B] Combinatorics** | |
| **Unit IV** | **Basic Counting Principles** | **10** |
| | Two Basic Counting Principles, Simple Arrangements and Selections, Arrangements and Selections with Repetitions, Distributions, Binomial Identities. | |
| **Unit V** | **Generating Functions** | **10** |
| | Generating Functions Models, Calculating Coefficients of Generating Functions, Partitions, Exponential Generating Functions. | |
| **Unit VI** | **Recurrence Relations** | **10** |
| | Recurrence Relations Models, Solutions of Linear Recurrence Relations, Counting with Venn Diagrams, Inclusion-Exclusion Formula. | |

**Reference Books:**


1. Douglas B. West: Introduction to Graph Theory; 2nd Edn; PHI Learning Pvt. Ltd.
2. Alan Tucker: Applied Combinatorics 6th Edn; Wiley India.Unit
3. B. Kolman, R. Busby, S.C. Ross: Discrete Mathematical Structures, 6th Edn, Pearson Edn.
4. John Clark, D. A. Holton: A First Look at Graph Theory, World Scientific, 1991.


**Website:**

1. https://www.youtube.com/watch?v=E40r8DWgG40&list=PLEAYkSg4uSQ2fXcfrTGZdPuTmv98bnFY5
2. https://nptel.ac.in/courses/111/106/111106155/

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|---|---|
| **Course/ Paper Title** | **Theoretical Computer Science** |
| **Course Code** | **23SMIMT11MEB** |
| **Semester** | **I** |
| **No. of Credits** | **04** |

| Unit No | Title with Contents | No. of Lectures |
|---|---|---|
| **Unit I** | **Overview of theory of mathematics**: | **05** |
| | Sets, Functions, Logical statements, Proofs, relations, languages, Mathematical induction, strong principle, Recursive definitions | |
| **Unit II** | **Introduction to Theory of Computations:** | **05** |
| | Fundamental concepts, history, Applications, Phases of Compiler, basic terminologies used in theory of computation: automata, symbol, alphabet, String | |
| **Unit III** | **Introduction to Regular Languages and Finite Automata:** | **05** |
| | Regular expressions, regular languages, applications, Automata with Output-Moore machine, Mealy machine, Finite automata, memory requirement in a recognizer, definition, union, intersection and complement of regular language, Non Determinism Finite Automata, Conversion from NFA to FA, Non Determinism Finite Automata Conversion of NFA to NFA and equivalence | |

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| | of three Kleene's Theorem, Minimization of Finite automata Regular and Non-Regular Languages - pumping lemma. | |
| **Unit IV** | **Grammar**: | **05** |
| | Introduction to Grammar, Definition, elements of grammar, Application areas and comparison of different grammars, Comparison | |
| **Unit V** | **Context Free Grammar** | **10** |
| | Importance of Context free grammar**,** Unions Concatenations and Kleen's of Context free language Regular grammar, Derivations and Languages, Relationship between derivation and derivation trees, Ambiguity Unambiguous CFG and Algebraic Expressions Bacos Naur Form (BNF), Normal Form – CNF. | |
| **Unit VI** | **Pushdown Automata, CFL and NCFL:** | **10** |
| | Pushdown Automata, CFL And NCFL: Definition, deterministic PDA, Equivalence of CFG and PDA, Pumping lemma for CFL, Intersections and Complements of CFL, Non-CFL | |
| **Unit VII** | **Turing Machine (TM):** | **10** |
| | TM Definition, Model of Computation and Church Turning Thesis, computing functions with TM, Combining TM, Variations of TM, Non-Deterministic TM, Universal TM, Recursively and Enumerable Languages, Context sensitive languages and Chomsky hierarchy | |
| **Unit VIII** | **Computable Functions** | **10** |
| | Partial, total, constant functions, Primitive Recursive Functions, Bounded Mineralization, Regular function, Recursive Functions | |

**Reference Books:**


1. John Hopcroft, Rajeev Motwani and Jeffrey Ullman, "Introduction to Automata theory, Languages and computation", 3rd edition Pearson Education, 2009.
2. Shirish S. Sane, "Theory of Computer Science", 2nd edition, 2007, Technical publication
3. Daniel I. A. Cohen, John Wiley & Sons, "Introduction to Computer Theory", 2nd edition, 2009

4. John E. Hopcroft and Jeffrey Ullman, "Introduction to Automata theory, Languages andcomputation" Narosa Publishing House,1979.

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|---|---|
| **Course/ Paper Title** | **Mathematical Analysis** |
| **Course Code** | **23SMIMT21MM** |
| **Semester** | **II** |
| **No. of Credits** | **04** |

| Unit No | Title with Contents | No. of Lectures |
|---|---|---|
| **Unit I** | **Basic Topology** | **10** |
| | Real Numbers and its properties, Finite, Countable & Uncountable sets, Metric Spaces. Compact Sets. Perfect Sets. Connected Sets. | |
| **Unit II** | **Numerical Sequences and Series** | **10** |
| | Convergent sequences, sub sequences, Cauchy sequences, Special sequences, Series, Series of non-negative terms, The number e, Root and Ratio tests, Power serie, Absolute Convergence | |
| **Unit III** | **Continuity** | **10** |
| | Limits of functions, Continuous functions, Continuity and Connectedness, Continuity and Compactness, Monotonic functions, Types of discontinuities | |
| **Unit V** | **Differentiation** | **10** |
| | Derivatives and Mean Value Theorems, Taylors theorem, Convex functions, Cauchy form of Remainder. Differentiation of Vector Valued functions. | |
| **Unit-VI** | **Riemann Integral** | **10** |
| | Concept of Partitions, Refinements, Upper and lower sums, Existence of Integral, Properties of Riemann Integral (without proof), Integral and Differentiation, Fundamental Theorem of Integral Calculus. | |

**Reference Books:**


1. Real Mathematical Analysis, by C. C. Pugh, Springer, New Delhi, 2004.
2. Functions of Several Real Variables, by Martin Moskowitz and Fotios Paliogiannis.
3. Methods of Real Analysis, by R. R. Goldberg, Oxford & IBH Publishing Company, 2019.
4. Advanced Calculus, by Gerald B. Folland, Pearson, 2012.
5. N. L. Carothers, Real analysis, Cambridge University Press India, 1999.
6. Foundations of Analysis, by Joseph L. Taylor, AMS, 2012.


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|---|---|
| **Course/ Paper Title** | **Calculus for Computer Science** |
| **Course Code** | **23SMIMT22MM** |
| **Semester** | **II** |
| **No. of Credits** | **04** |

| Unit No | Title with Contents | No. of Lectures |
|---|---|---|
| **Unit I** | **Differential Calculus of Scalar and Vector Fields:** | **20** |
| | Functions from $R^n$ to $R^m$. Scalar and vector fields; Open balls and open sets; Limits and continuity.<br>The derivative of a scalar field with respect to a vector; Directional derivatives and partial derivatives; Partial derivatives of higher order; Inverse function theorem and Implicit Function theorem. (Statement only without proof)<br>Directional derivatives and continuity; The total derivatives; The gradient of a scalar field; A sufficient condition for differentiability.<br>A chain rule for derivatives of scalar fields; Applications to geometry. Level sets. Tangent planes; Derivatives of vector fields; Differentiability implies continuity; The chain rule for derivatives of vector fields; Matrix form of the chain rule | |
| **Unit II** | **Line Integrals:** | **10** |
| | Paths and line integrals; Other notations for line integrals; Basic properties of line integrals.<br>The concept of work as a line integral; Line integrals with respect to arc length; Further applications of line integrals. | |

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| | Open connected sets. Independence of the path; The first and second fundamental theorem of calculus for line integrals; Necessary and sufficient conditions for a vector field to be a gradient; Necessary conditions for a vector field to be a gradient. | |
| **Unit III** | **Multiple Integrals:** | **15** |
| | Partitions of rectangles. Step functions; The double integral of a step function; The definition of the double integral of a function defined and bounded on a rectangle; Upper and lower double integrals;<br>Evaluation of double integral by repeated one-dimensional integration; Geometric interpretation of the double integral as a volume; Worked examples.<br>Integrability of continuous functions; Integrability of bounded functions with discontinuities; Double integrals extended over more general regions; Applications to area and volume;Worked examples.<br>Green's theorem in the plane; Some applications of Green's theorem; A necessary andsufficient condition for a two dimensional vector field to be a gradient.<br>Change of variables in a double integral; Special cases of the transformation formula withproof; General case of the transformation formula with proof; Extensions to higher dimensions; Change of variables in an n-fold integral; Worked examples. | |
| **Unit IV** | **Surface Integrals:** | **15** |
| | Parametric representation of a surface; The fundamental vector product; The fundamentalvector product as a normal to the surface; Area of a parametric surface.<br>Surface integrals; Change of parametric representation; Other notations for surface integrals.<br>The theorem of Stokes; Curl and divergence of a vector field; Properties of curl and divergence;the divergence theorem (Gauss' theorem) and applications of the divergence theorem. | |

**Reference Books:**

1.Tom M. Apostol, Calculus Volume II (Second Edition) Indian Reprint 2016 (John Wiley & Sons, Inc) ISBN: 978-81-265-1520-2.

2. For " Inverse Function Theorem" and "Implicit Function Theorem", use

Tom M. Apostol, Mathematical Analysis 2nd Edition Narosa Publication 20th Reprint 2002. ISBN 978-81-85015-66-8.

3. Gerald B. Folland, Advanced Calculus, Pearson Edn 2012.

4. A Devinatz, Advanced Calculus, Holt, Rnehart and Winston Inc., New York, 1968.

**Website**

1. Multivariable Calculus Intructor: Dr. S.K.Gupta IIT Roorkee

https://www.youtube.com/results?search_query=multi+variable+calculus+nptel

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|---|---|
| **Course/ Paper Title** | **C++- Programming** |
| **Course Code** | **23SMIMT23MM** |
| **Semester** | **II** |
| **No. of Credits** | **02** |

| Unit No | Title with Contents | No. of Lectures |
|---|---|---|
| **Unit I** | **Introduction to C++** | **2** |
| | History, Features of C++, Structure of C++ program, Variables, Data Types, Keywords, Operators, Namespaces, using Keyword, I/O Stream, References in C++, C vs C++, Programming Examples | |
| **Unit II** | **Control Statements** | **2** |
| | Decision Making Statements: if, if-else, switch Loop Control Structures: while, do. While, for Keywords- break and continue, Comments, Programming Examples | |
| **Unit III** | **Functions** | **2** |

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|---|---|---|
| | Concept, Usage of a Function, Types of Function, Call by Value, Call by Reference and Call by Address, References vs Pointers, Return by Reference, Inline Function, Default Arguments Concept, Recursion, Programming Examples | |
| **Unit IV** | **Arrays** | **3** |
| | Arrays, Passing Array to Function, Multidimensional Arrays, Programming Examples | |
| **Unit V** | **Strings** | **3** |
| | Concept, Operations on Strings, Standard Library String Functions, Programming Examples | |
| **Unit VI** | **Class and Objects** | **6** |
| | OOPs concepts: Encapsulation, Inheritance, Polymorphism, Abstraction Object, Class, Constructor, Types of Constructor (Default, Parameterised, Copy), Destructor, Virtual Destructor, this Pointer, static Members (Fields & Member Functions), Structs, Friend Function, Programming Examples | |
| **Unit-VII** | **Inheritance & Aggregation** | **6** |
| | Concept, Advantages, Types of Inheritance, Aggregation, Programming Examples | |
| **Unit VIII** | **Polymorphism** | **6** |
| | Concept, Function overloading, Operator overloading, Function overriding, Virtual function, Virtual base class, Programming Examples | |
| **Unit IX** | **Abstract Class** | **6** |
| | Concept, Pure Virtual Function, Interface, Programming Examples | |
| **Unit X** | **File & Stream** | **8** |
| | Concept, I/O Manipulators (endl, flush, setfill, setprecision, setw), fstream, ifstream, ofstream, File I/O, Programming Examples | |
| **Unit XI** | **Exceptional Handling** | **8** |

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|---|---|---|
| | Concept, Exception Handling Keywords (try, catch, throw), Advantages, Standard Exception Classes in C++, User-defined Exceptions, Programming Examples | |
| **Unit XII** | **Templates** | **8** |
| | Concept, Function Template, Overloading of Function Template, Restrictions on Generic Functions, Class Template, Programming Examples | |
| **Unit XIII** | **Introduction to STL (Standard Template Library)** | **8** |
| | Concept, Containers (Stack, Queue, Vector, List), Algorithms (Sorting, Searching), Iterator, Programming Examples | |

**Reference Books:**


1. Herbert Schildt, The Complete Reference C++, Tata McGraw Hill, 4th Edition, 2003
2. Herbert Schildt, C++ Programming Cookbook, Tata McGraw Hill, 2008
3. Bjarne Stroustrup, The C++ Programming Language, Pearson, 4th Edition4.
4. Lafore Robert, Object-Oriented Programming with C++, Pearson, 4th Edition, 2010
5. Kanetkar Yashavant, Let us C++, BPB Publications, 2nd Edition, 2010


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|---|---|
| **Course/ Paper Title** | **Web Development** |
| **Course Code** | **23SMIMT24MM** |
| **Semester** | **II** |
| **No. of Credits** | **02** |

| Unit No | Title with Contents | No. of Lectures |
|---|---|---|
| **Unit I** | **Foundation** | **02** |
| | The Node.js framework, Installing Node.js, Using Node.js to execute scripts | |
| **Unit II** | **HTTP and HTTPs** | **04** |
| | Making a simple server, when to use HTTP and HTTPs, Server ports and listening, HTTP requests and responses, Request and response | |

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|---|---|---|
| | headers and body, Creating a response to incoming requests, Building a simple HTTP server with static files | |
| **Unit III** | **File System & Modules** | **04** |
| | Synchronous vs. asynchronous I/O, Path and directory operations, dirname and –filename, Asynchronous file reads and writes, Defining modules with exports, Modules are singletons, Creating a package, Module scope and construction | |
| **Unit IV** | **Buffers, Streams, and Events** | **05** |
| | Using buffers for binary data, flowing vs. non-flowing streams, Streaming I/O from files and other sources, processing streams asynchronously, Configuring event handlers. | |
| **Unit V** | **Express** | **05** |
| | The model-view-controller pattern, Building a front-end controller, Defining routes, Creating actions, Using REST, Reading POST data, Building Handlebars helpers, Adding middleware | |
| **Unit VI** | **Data Sources** | **05** |
| | How Node.js connects to databases, RDBMS databases and NoSQL databases, Connecting to RDBMS and NoSQL databases, Performing CRUD operations, Building client requests to web services. | |
| **Unit-VII** | **Angular Components** | **05** |
| | Component Life Cycle, Services, Single Page Applications, Directives, Forms, Pipes, Communication Between Component | |

**Reference Books:**


1. Aristeidis Bampakos, Pablo Deeleman, Learning Angular: A no-nonsense beginner's guide to building web applications with Angular 10 and TypeScript, 3rd Edition
2. Jeremy Wilken, Angular in Action
3. Frank Zammetti, Modern Full-Stack Development: Using TypeScript, React, Node.js, Webpack, Python, Django, and Docker.


**Websites**

1. https://docs.angularjs.org/
2. https://nodejs.org/en/docs/

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|---|---|
| **Course/ Paper Title** | **Coding Theory** |
| **Course Code** | **23SMIMT21MEA** |
| **Semester** | **II** |
| **No. of Credits** | **04** |

| Unit No | Title with Contents | No. of Lectures |
|---|---|---|
| **Unit I** | **Error detection, correction and decoding** | **12** |
| | Introduction, Communication channels, Maximum likelihood decoding, Hamming distance, Nearest neighbour / minimum distance decoding, Distance of a code. | |
| **Unit II** | **Finite fields** | **12** |
| | Fields, Polynomial rings, Structure of finite fields, Minimal polynomials | |
| **Unit III** | **Linear Codes** | **16** |
| | Vector spaces over finite fields., Linear codes, Hamming weight, Bases for linear codes, Generator matrix and parity–check matrix, Equivalence of linear codes, Encoding with a linear code, Decoding of linear codes: Cosets; Nearest neighbour decoding for linear codes; Syndrome decoding. | |
| **Unit IV** | **Bounds in coding theory** | **08** |
| | The main coding theory problem, Lower bounds: Sphere–covering bound;Gilbert–Varshamov bound, Hamming bound and perfect codes: Binary, Hammingcodes; Golay codes, Singleton bound and MDS codes. | |
| **Unit V** | **Cyclic codes** | **08** |

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| | Definitions, Generator polynomials, Generator and parity–check matrices, Decoding of cyclic codes. | |
| **Unit VI** | **Some special cyclic codes** | **04** |
| | BCH codes: Definitions; Parameters of BCH codes. | |

**Reference Books:**


1. San Ling, Chaoping Xing, Coding Theory, A First Course; Cambridge University Press, 2004.
2. Raymod Hill, A First Course in Coding Theory, Oxford University Press.
3. Rudolf Lidl, Günther Pilz, Applied Abstract Algebra, Second Edition, Springer, Reprint 2004.


**Website:**

1. https://nptel.ac.in/courses/117/106/117106031/
2. https://nptel.ac.in/courses/108/104/108104092/

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|---|---|
| **Course/ Paper Title** | **Numerical Analysis** |
| **Course Code** | **23SMIMT21MEB** |
| **Semester** | **II** |
| **No. of Credits** | **04** |

| **Unit No** | **Title with Contents** | **No. of Lectures** |
|---|---|---|
| **Unit I** | **Root Finding Methods:** | **08** |
| | Convergence; Floating Point Number Systems; Floating Point Arithmetic.<br>Fixed Point Interaction Schemes; Newton's Method; Secant Method; Accelerating Convergence | |
| **Unit II** | **System of Equations:** | **14** |

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| | Gaussian Elimination; Pivoting Strategies.<br>Error Estimates and Condition Number; LU decomposition; Direct Factorization.<br>Iterative Techniques for Linear Systems: Basic Concepts and Methods.<br>Nonlinear Systems of Equations. | |
| **Unit III** | **Eigenvalues and Eigenvectors:** | **05** |
| | The Power Method, The Inverse Power Method, Reduction to Symmetric Tridiagonal Form, Eigenvalues of Symmetric Tridiagonal Matrices. | |
| **Unit IV** | **Interpolation (and Curve Fitting):** | **09** |
| | Lagrange Form of Interpolating Polynomial, Neville's Algorithm, The Newton Form of Interpolating Polynomial, Optimal Points for Interpolation, Piecewise Linear Interpolation, Cubic Spline Interpolation. | 2 |
| **Unit V** | **Differentiation and Integration:** | **12** |
| | Numerical Differentiation, Numerical Integration – The Basics and Newton-Cotes Quadrature; Composite Newton- Cotes Quadrature. | |
| **Unit VI** | **Initial Value Problems of Ordinary Differential Equations:** | **12** |
| | Euler's Method; Higher-Order One-Step Methods: Taylor Methods, Runge-Kutta Methods, Multistep Methods (Adams-Bashforth Methods, The Two Step Adams-Bashforth Method, Milnes's Method, Convergence and Stability Analysis. | |

**Reference books:**

1. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Prentice Hall 2007, ISBN 978-81-317-0942-9.

2. John H. Mathews, Kurtis D. Fink, Numerical Methods Using Matlab, 4th Edition,

Pearson Education (Singapore) Pte. Ltd., Indian Branch, Delhi 2005.

(SciLab commands similar to MatLab commands can be used for problems)

3. K .E. Atkinson, An Introduction to Numerical Analysis, Second Edition, John Wiley & Sons.

4. J. L. Buchaman, P. R. Turner, Numerical Methods and Analysis, McGraw Hill, 1992.

5. M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Methods for Scientific & Engineering Computation, 5th Edition, New Age International Publication

6. Numerical Method Kit: For matlab, Scilab and Octave Users by Rohan Verma University of Delhi Independently published in 2020.

7. G Shanker Rao, Numerical Analysis, New Age International, 2006.

8. S.S.Sastry, Sastry Introductory Methods of Numerical Analysis Fifth Edition, PHI Learning Private Limited.

**2. Website:**

Numerical Analysis Instructor: Prof Usha Department Of Mathematics IIT Madras
https://www.youtube.com/results?search_query=numerical+analysis+nptel