

NEP CBCS: 2023-2024 M.Sc.-I Industrial Mathematics with Computer Applications



M. C. E. Society's

Abeda Inamdar Senior College

Of Arts, Science and Commerce, Camp, Pune-1 (Autonomous)

Affiliated to Savitribai Phule Pune University NAAC 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

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.

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.	23SMIMT33PM M: 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

	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:

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 bases 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, computer 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

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 of Subgroups, 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 of Isomorphism, 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,	

	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.

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 Note: This unit will not be considered for an assessment of students	

Unit IV	Control Statements	2
	Decision Making Statements: if, if-else, switch Loop Control Structures: while, do. while, for 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	

	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

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

	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: 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 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/>

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, Preparation and Compilation of LaTeX input file. 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	

	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

	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
	<p>Graphs; Graphs as Models; Matrices and Isomorphism; Decomposition and Special Graphs; Degree of a vertex; Counting and Bijections.</p> <p>Paths, Cycles, Trails: Connection in Graphs; Bipartite Graphs; Eulerian Circuits; Hamiltonian Cycles.</p> <p>Directed Graphs: Definition and Examples; Vertex Degrees; Eulerian Digraphs.</p>	
Unit II	Trees	12
	<p>Trees: Properties of Trees; Distance in Trees and Graphs.</p> <p>Enumeration of Trees: Spanning Trees in Graphs; Minimum Spanning Trees; Shortest Paths; Connectivity; Edge Connectivity.</p> <p>Trees in Computer Science.</p>	
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/>

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	

	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 and computation" Narosa Publishing House, 1979.

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.

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
	<p>Functions from \mathbb{R}^n to \mathbb{R}^m. Scalar and vector fields; Open balls and open sets; Limits and continuity.</p> <p>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)</p> <p>Directional derivatives and continuity; The total derivatives; The gradient of a scalar field; A sufficient condition for differentiability.</p> <p>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</p>	
Unit II	Line Integrals:	10
	<p>Paths and line integrals; Other notations for line integrals; Basic properties of line integrals.</p> <p>The concept of work as a line integral; Line integrals with respect to arc length; Further applications of line integrals.</p>	

	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
	<p>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; Evaluation of double integral by repeated one-dimensional integration; Geometric interpretation of the double integral as a volume; Worked examples.</p> <p>Integrability of continuous functions; Integrability of bounded functions with discontinuities; Double integrals extended over more general regions; Applications to area and volume; Worked examples.</p> <p>Green's theorem in the plane; Some applications of Green's theorem; A necessary and sufficient condition for a two dimensional vector field to be a gradient.</p> <p>Change of variables in a double integral; Special cases of the transformation formula with proof; General case of the transformation formula with proof; Extensions to higher dimensions; Change of variables in an n-fold integral; Worked examples.</p>	
Unit IV	Surface Integrals:	15
	<p>Parametric representation of a surface; The fundamental vector product; The fundamental vector product as a normal to the surface; Area of a parametric surface.</p> <p>Surface integrals; Change of parametric representation; Other notations for surface integrals.</p> <p>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.</p>	

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 Instructor: Dr. S.K.Gupta IIT Roorkee

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

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

	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

	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 Edition.
4. Lafore Robert, Object-Oriented Programming with C++, Pearson, 4th Edition, 2010
5. Kanetkar Yashavant, Let us C++, BPB Publications, 2nd Edition, 2010

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	

	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/>

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, Hamming codes; Golay codes, Singleton bound and MDS codes.	
Unit V	Cyclic codes	08

	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/>

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. Fixed Point Iteration Schemes; Newton's Method; Secant Method; Accelerating Convergence	
Unit II	System of Equations:	14

	Gaussian Elimination; Pivoting Strategies. Error Estimates and Condition Number; LU decomposition; Direct Factorization. Iterative Techniques for Linear Systems: Basic Concepts and Methods. 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