

**Modern Education Society's
Nowrosjee Wadia College
(AUTONOMOUS)**



NAAC Accredited A+ with CGPA 3.51

Affiliated to the
Savitribai Phule Pune University
(Formerly University of Pune)

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

**M. Sc. (Industrial
Mathematics with
Computer Applications)**
Semester I and Semester II

National Education Policy (NEP) Revised Syllabus
To be implemented from Academic Year 2025-2026

1. Preamble of the Syllabus

In compliance with the directives from the University Grants Commission, under the autonomous status of the college, the syllabus for Mathematics at the undergraduate level is revised and reframed as per the National Educational Policy (NEP 2020) curriculum framework. Nowrosjee Wadia College has decided to change the syllabi for the degree of M.Sc. from June 2023, as the college has already shifted to the autonomous status from the academic year 2022-2023. The present syllabus is prepared by the Board of Studies in Mathematics, Nowrosjee Wadia College, taking into consideration the present relevance and application of the various branches of Mathematics. While preparing this syllabus the U.G.C. model curriculum (LOCF) and existing syllabus given by Savitribai Phule Pune University is followed.

2. Objectives

- To create deep interest in learning mathematics.
- Develop broad and balanced knowledge and understanding of definitions, concepts, principles.
- Familiarize the students with suitable tools of mathematical analysis to handle issues and problems in mathematics and related sciences.
- Enhance the ability of learners to apply the knowledge and skills acquired by them during the programme to solve specific theoretical and applied problems in mathematics.
- Provide students/ learners sufficient knowledge and skills enabling them to undertake further studies in mathematics and its allied areas on multiple disciplines concerned with mathematics.
- Encourage the students to develop a range of generic skills helpful in employment, internships and social activities.

3. Programme Outcomes

- Master's degree in industrial mathematics with computer applications is the culmination of in-depth knowledge of algebra, real analysis, statistics, differential equations and several other branches of mathematics. This also leads to study of C-programming, JAVA, Python, etc. Thus, this programme helps learners in building a solid foundation for higher studies in mathematics as well as computer science.
- The skills and knowledge gained has intrinsic beauty, which also leads to proficiency in analytical reasoning. This can be utilised in modelling and solving real life problems.
- Students undergoing this programme learn to logically question assertions, to recognise patterns and to distinguish between essential and irrelevant aspects of problems. They also share ideas and insights while seeking and benefitting from knowledge and insight of others. This helps them to learn behave responsibly in a rapidly changing interdependent society.
- Students completing this programme will be able to present mathematics clearly and precisely, make vague ideas precise by formulating them in the language of mathematics, describe mathematical ideas from multiple perspectives and explain fundamental concepts of mathematics to non-mathematicians.
- Completion of this programme will also enable the learners to join teaching profession in primary and secondary schools.
- Completion of this programme will also enable the learners to join as developer, tester, data analyst in IT companies.
- This programme will also help students to enhance their employability for government jobs, jobs in banking, insurance and investment sectors, data analyst jobs and jobs in various other public and private enterprises.

4. Eligibility

B.Sc. (Mathematics) or any Science graduate with Mathematics at least up to second year or B.C.S./ B.E. / B.Tech. are eligible for admission to the course. Students graduating under NEP (B. A. & B. Sc.) with Mathematics as Major or Minor are eligible for admission to the course.

5. Duration of the Course:

The duration of the M.Sc. Industrial Mathematics with Computer Applications Program shall extend over 4 semesters (two academic years) of 15 weeks or more, each with a maximum of 90 actual working days of instruction in each semester.

6. Medium of instruction:

The medium of instruction shall be English.

7. Teaching Scheme:

- The course is a 2 year, 4 semesters full time post graduate course.
- The course follows the NEP (National Educational Policy 2020) pattern as per Government of Maharashtra G.R(s) as follows:

सांकेतांक २०२३०४२०१९२५२६६९०८

शासन निर्णय क्रमांक: एनईपी-२०२२/प्र.क्र.०९/विशि-३ शिकाना, दिनांक २० एप्रिल, २०२३

4 credit theory course = 60 hours (60 lectures)

2 credit theory courses = 30 hours (30 lectures)

2 credit practical course = **60 hours (4 hours/ week/ batch)**

8. Abbreviations

OE: Open Elective

AEC: Ability Enhancement Course

VEC: Value Education Courses

CC: Co-Curricular Courses

IKS: Indian Knowledge System

OJT: On Job Training

FP: Field Project

VS: Vocational Skill Courses

CEP: Community Engagement Project

T: Theory

P: Practical

CE: Continuous Evaluation

SEE: Semester End Examination

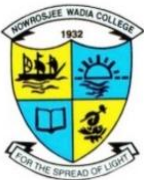
F.Y.: First Year


S.Y.: Second Year

R.P.: Research Project


R. M.: Research Methodology

YEAR	Level	Sem	Mandatory	Credit	elective(select one)	RM	OJT/FP	RP	Cum Cr	degree								
I	6	Sem I	Discrete Mathematical Structures	4	Statistical Methods	4	—	—	20-22	PG Diploma (after 3 yr degree)								
			Linear Algebra and its applications	4														
			C-Programming and DBMS	4	Software Engineering													
			LAB on C-Programming and DBMS	2														
		Sem II	Real Analysis	4	Computational Geometry						(Mini project) - 4 credit	20-22						
			Algebra	4														
			Data Structure and Core JAVA	4	Data Analysis Using Python													
			LAB on Data Structure and Core JAVA	2														
		Cum . Cr. For PG Diploma			24-28									8	4	4	40-44	
		Exit Option: PG Diploma (40-44 credits) after three year UG Degree																
II	6.5	Sem III	Design and Analysis of Algorithms	4	Numerical Analysis 2T+ 2P		—	4 credit (mini project)	20-22	PG Degree (after 3 yr degree) Or PG Degree (after 4 yr degree)								
			Advanced JAVA	2														
			LAB on Advanced JAVA	2	Cryptography (2T+2P)													
			Computer Networks	2														
			LAB on Data Science	2														
		Sem IV	Operations Research	2T+2P	Web Technology 2T+2P						—	6 credit	20-22					
			Ordinary Differential Equations	2T+2P	Digital Image Processing													
			AIML	2T+2P														
		Cum. Cr. for 1 Yr PG Degree			22-26							8		10	40-44			
		Cum. Cr. for 2 Yr PG Degree			46-54							16	4	4	10	80-88		

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
	Masters of Science (Industrial Mathematics with Computer Applications)	
Major (Theory) Subject: Mathematics SEMESTER – I		
Year - 1	Paper No: MIMMJ111	Credits 4
Semester-I	Name of Paper: Discrete Mathematical Structures	Hours 60
<p>Course specific outcomes- This course will enable the student to: CO1: Understand and apply counting techniques to real life problems. CO2: Represent a graph using an adjacency list and an adjacency matrix and apply graph theory to application problems such as computer network. CO3: Perform tree traversal and apply to application problems like binary search trees or decision trees to solve problems. CO4: Determine if a graph has an Euler or a Hamilton path or circuit. CO5: Evaluate Boolean functions and simplify expression using the properties of Boolean algebra; apply Boolean algebra to circuits and gating networks.</p>		
COURSE CONTENT/ SYLLABUS		Lectures
<p>Unit 1-Counting Techniques The Basics of Counting, The Pigeonhole Principle, Permutations and Combinations, Binomial Coefficients, Generalized Permutations and Combinations, Applications of Recurrence Relations, Solving Linear Recurrence Relations, Divide-and-Conquer Algorithms and Recurrence Relations.</p>		16
<p>Unit 2 - Graphs Graphs and Graph Models, Graph Terminology and Special Types of Graphs, Representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest-Path Problems, Planar Graphs, Graph Coloring.</p>		16
<p>Unit 3 - Trees Introduction to Trees, Applications of Trees, Tree Traversal – preorder, inorder, postorder, Spanning Trees, Minimum Spanning Trees.</p>		16
<p>Unit 4 - Boolean Algebra Boolean Functions, Representing Boolean Functions, Logic Gates, Minimization of Circuits.</p>		12
References	<ol style="list-style-type: none"> 1. Kenneth H. Rosen, DISCRETE MATHEMATICS AND ITS APPLICATIONS, SEVENTH EDITION, Tata McGraw-Hill Publishing Company Limited, Special Indian Edition 2007 (6.1-6.5, 8.1-8.3, 10.1-10.8, 11.1-11.5, 12.1-12.4) 2. Narsingh Deo, Graph Theory with Applications to Computer Science and Engineering, PHI Publication. 3. C. L. Liu, Elements of Discrete Mathematics, Tata McGraw Hill. 	
Learning outcomes	<p>After the course the student will be able to: LO1: Apply these concepts to solve practical problems that arise in physics and other related areas. LO2: Enhance logical thinking. LO3: Express a logic sentence in terms of predicates, quantifiers, and logical connectives. LO4: Use tree and graph algorithms to solve problems.</p>	


	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
	Masters of Science (Industrial Mathematics with Computer Applications)	
Major (Theory) Subject: Mathematics SEMESTER –I		
Year – 1	Paper No: MIMMJ112	Credits 4
Semester-I	Name of Paper: Linear Algebra and its applications	Hours 60
Course specific outcomes-This course will enable the students to:		
CO1: Understand algebraic and geometric representations of vectors in R^n and their operations, including addition, scalar multiplication and dot product		
CO2: Explain the significance of eigenvectors and eigenvalues		
CO3: Understand how to determine the angle between vectors and the orthogonality of vectors.		
CO4: Use characteristic polynomials to compute eigenvalues and eigenvectors		
CO5: Discuss the kernel and image of a linear transformation in terms of nullity and rank of the matrix		
CO6: Discuss simultaneous diagonalisation and simultaneous triangulation		
CO7: Discuss decomposition of matrices		
COURSE CONTENT/ SYLLABUS		Lectures
Unit 1- General Vector Spaces Real Vector Spaces, Subspaces, Linear Independence, Basis and Dimension, Row Space, Column Space and Null Space, Rank and Nullity.		10
Unit 2- Inner Product Spaces Inner Products, Angle and Orthogonality in Inner Product Spaces, Orthonormal Bases: Gram-Schmidt Process		9
Unit 3- Eigenvalues, Eigenvectors Eigenvalues and Eigenvectors, Diagonalization, Orthogonal Diagonalization		13
Unit 4- Linear Transformations General Linear Transformations, Kernel and Range, Inverse Linear Transformations, Matrices of General Linear Transformations		9
Unit 5- Elementary Canonical Forms Introduction, Characteristic Values, Annihilating Polynomials, Invariant Subspaces, Simultaneous Triangulation; Simultaneous Diagonalization.		10
Unit 6- Applications of Linear Algebra Geometry of Linear Operators on R^2 , Approximation Problems; Fourier Series, LU-Decomposition, Cryptography		9


References	<p>1. Elementary Linear Algebra (Applications Version); Howard Anton and Chris Rorres, 9th Edition, Wiley Student Edition Chapter 5: Sec.5.1 to Sec.5.6 Chapter 6: Sec. 6.1 to Sec. 6.3 Chapter 7: Sec. 7.1 to Sec. 7.3 Chapter 8: Sec. 8.1 to Sec. 8.4 Chapter 9: Sec. 9.2; Sec. 9.4; Sec. 9.9 Chapter 11: Sec. 11.16</p> <p>2. Linear Algebra; Kenneth Hoffman, Ray Kunze, 2nd Edition, PHI Chapter 6: Sec.</p> <p>2. Linear Algebra and its Applications; 5th Edition, David C. Lay, Stephen R. Lay, Judi J. Mc Donald, Pearson Publications</p> <p>3. Introduction to Linear Algebra; Krishnamurthy</p> <p>4. Schaum's Outline of Linear Algebra; 3rd Edition</p>
Learning outcomes	<p>After the course the student will be able to:</p> <p>LO1: compute the inverse of an invertible matrix</p> <p>LO2: find the null space of a matrix and represent it as the span of independent vectors.</p> <p>LO3: find the matrix representation of a linear transformation given bases of the relevant vector spaces.</p> <p>LO4: create orthogonal and orthonormal bases: Gram-Schmidt process and use bases and orthonormal bases to solve application problems.</p> <p>LO5: compute spectral values for given matrices.</p> <p>LO6: find Fourier series approximations for given functions.</p>

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
Masters of Science (Industrial Mathematics with Computer Applications)		
Major (Theory) Subject: SEMESTER – I		
Year - 1	Paper No: MIMMJ113	Credits 4
Semester-I	Name of Paper: C-Programming and DBMS	Hours 60
Course specific outcomes- This course will enable the student to: CO1: Design E-R Model for given requirements and convert the same into database tables. CO2: Use Relational database techniques such as PgSQL& PL/SQL. CO3: Develop modular programs using arrays in 'C'. CO4: Understand basic programming concepts.		
COURSE CONTENT/ SYLLABUS		Lectures
Unit 1- Introduction to DBMS 1.1 File system Vs. DBMS 1.2 Describing & storing data (Data models- Relational, Hierarchical, Network) 1.3 Levels of Abstraction, Data Independence. 1.4 Queries in DBMS (SQL: DDL, DML, DCL, TCL). 1.5 Structure of DBMS		4
Unit 2 - Conceptual Design: ER model 2.1 Overview of DB design. 2.2 ER data model (entities, attributes, entity sets, relations, relationship sets) 2.3 Additional constraints (key constraints, participation, constraints, weak entities, aggregation / generalization. 2.4 Conceptual design using ER (entities Vs. attributes, Entity Vs. relationship, binary Vs. ternary, constraints beyond ER)		7
Unit 3- Relational data model and Relational algebra 3.1 Relations (concepts, definition) 3.2 Conversion of ER to Relational model, integrity constraints- key, referential integrity, general constraints) 3.3 Relational algebra Preliminaries. 3.4 Relational algebra (selection, projection, set operations, renaming, joins, division). 3.5 Advance RA operators (Aggregate operators)		7
Unit 4-SQL 4.1 DDL (create, drop, alter) 4.2 Forms of a basic SQL query (egs, expressions, strings in SQL) 4.3 Union / intersection / except, nested queries (introduction 4.4 Correlated queries 4.5 Set comparison operators) 4.6 Aggregate operators (group by, having), aggregate functions.		8

4.7 Null values (comparison using NULL, logical connections (AND, OR, NOT) impact on SQL commands, outer joins, disallowing NULL)	
Unit 5- Functional dependency 5.1 Introduction to schema refinement. 5.2 Use of decomposition. 5.3 Functional dependencies. 5.4 F+, attribute closure. 5.5 Algorithm for identifying super keys. 5.6 Normalization forms (1NF, 2NF, 3NF, BCNF)	5
Unit 6-Introduction, Types, Operators, and Expressions 6.1 Introduction to C Programming language. 6.2 Variable Names, Data Types and Sizes. 6.3 Constants, Declarations 6.4 Arithmetic Operators, Relational and Logical Operators. 6.5 Type Conversions. 6.6 Increment and Decrement Operators, Bitwise Operators, Assignment Operators and Expressions. 6.7 Conditional Expressions. 6.8 Precedence and Order of Evaluation.	6
Unit 7-Control Flow 7.1 Statements and Blocks. 7.2 If-Else, Else-If, Switch. 7.3 Loops- While and For, Do-while. 7.4 Break and Continue 7.5 Go to and Labels.	5
Unit 8- Functions and Program Structure 8.1 Basics of Functions. 8.2 Functions Returning Non-integers. 8.3 External Variables. 8.4 Scope Rules. 8.5 Header Files. 8.6 Static Variables, Register Variables. 8.7 Block Structure. 8.8 Initialization. 8.9 Recursion. 8.10 The C Preprocessor.	6
Unit 9-Pointers and Arrays 9.1 Pointers and Addresses. 9.2 Pointers and Function Arguments. 9.3 Pointers and Arrays. 9.4 Address Arithmetic. 9.5 Character Pointers and Functions. 9.6 Pointer Arrays; Pointers to Pointers. 9.7 Multi-dimensional Arrays. 9.8 Initialization of Pointer Arrays. 9.9 Pointers vs. Multi-dimensional Arrays. 9.10 Command-line Arguments. 9.11 Pointers to Functions. 9.12 Complicated Declarations.	8


Unit 10- Structures 10.1 Structures and Functions. 10.2 Arrays of Structures. 10.3 Pointers to Structures. 10.4 Self-referential Structures. 10.5 Typedef. 10.6 Unions.	4
References	<ol style="list-style-type: none"> 1. Fundamentals of Database Systems (4th Ed) By: Elmasri and Navathe 2. Database System Concepts (4th Ed) By: Korth, Sudarshan, Silberschatz 3. Practical PostgreSQL: O'reilly Series 4. Kernighan and Ritchie: The C Programming language. 5. Forouzan and Gilberg: Structured Programming approach using C, Thomson learning Publications. 6. Herbert Schildt: Complete C Reference.
Learning outcomes	<p>After the course the student will be able to:</p> <p>LO1: Create an Entity-Relationship model from realistic problem specification.</p> <p>LO2: Write SQL commands to create tables and indexes, insert/update/delete data, and query data in a relational DBMS.</p> <p>LO3: Apply different types of Normalization techniques.</p> <p>LO4: Understand fundamental programming concepts and methodology (variables, assignments, conditions, loops, functions).</p> <p>LO5: Work with Pointers and Arrays.</p>

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
	Masters of Science (Industrial Mathematics with Computer Applications)	
Major (Practical) Subject: SEMESTER – I		
Year - 1	Paper No: MIMMJ115	Credits 2
Semester-I	Name of Paper: Practical based on C-Programming and DBMS	Hours 60
<p>Course specific outcomes- This course will enable the student to: CO1: Apply the basic concepts of Database Systems and Applications. CO2: Use the basics of SQL and construct queries using SQL in database creation and interaction. CO3: Understand execution of program for statements, loops etc. CO4: Create functions, arrays for programming purpose.</p>		
COURSE CONTENT/ SYLLABUS		
<p>1- Practical based on Conceptual Designing using ER Diagrams. Identifying entities, attributes, keys and relationships between entities, cardinalities, generalization, specialization etc.</p> <p>2 - Practical based on Converting ER Model to Relational Model. Represent entities and relationships in Tabular form, represent attributes as columns, identifying keys</p> <p>3- Practical based on Normalization To remove the redundancies and anomalies in the relational tables, Normalize up to Third Normal Form.</p> <p>4-Practical based on Creation of Tables using SQL. Overview of using SQL tool, Data types in SQL, Creating Tables (along with Primary and Foreign keys), Altering Tables and Dropping Tables.</p> <p>5-Practical based on DML commands, Queries, Sub queries. Insert, Select, Update, Delete commands. Queries using ANY, ALL, IN, EXISTS, NOT EXISTS, UNION, INTERSECT, CONSTRAINTS. Sub queries (Nested, Correlated) and Joins (Inner, Outer)</p> <p>6-Practical based on Aggregate functions. Queries using COUNT, SUM, AVG, MAX, MIN, GROUP BY, HAVING.</p>		
References	F. Y. B. Sc. (Comp. Science) Laboratory Course II Workbook: Lab Course I, Lab Course II- Section II	
Learning outcomes	<p>After the course the student will be able to: LO1: Create tables in database and run SQL queries. LO2: Execute SQL queries, nested queries, and queries with operators. LO3: Understand relationship between tables/reasons through queries. LO4: Solve mathematical problems using aggregate functions. LO5: Understand actual implementation of basic programming concepts.</p>	


	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
	Masters of Science (Industrial Mathematics with Computer Applications)	
Elective (Theory) Subject SEMESTER – I		
Year - I	Paper No- MIMMJ114A	Credits 4
Semester-I	Name of Paper- Statistical Methods	Hours 60
<p>Course specific outcomes- After Successful completion of this course students can able to</p> <p>CO1: To introduce and explain concepts and methods of Descriptive Statistics for real data</p> <p>CO2: To understand basic terminology of probability theory and to explain probability theory and also to revise prerequisite concepts like set theory etc</p> <p>CO3: To introduce basic results related to discrete and continuous random variables</p> <p>CO4: To get very elementary idea and knowledge of R Software</p> <p>CO5: To understand basic terminology and techniques of correlation and regression analysis for bivariate</p> <p>CO6: To apply these to some real life data model</p> <p>CO7: To understand basics of testing of hypothesis</p> <p>CO8: To understand procedures different of tests of hypothesis and apply them in problem situations</p>		
COURSE CONTENT / SYLLABUS		Lectures
<p>Unit 1- Theory of Probability and Random Variables</p> <p>1.1 Deterministic and non-determination models.</p> <p>1.2 Random Experiment, Sample Spaces (Discrete and continuous)</p> <p>1.3 Events: Types of events, Operations on events.</p> <p>1.4 Probability - classical definition, probability models, axioms of probability, probability of an event.</p> <p>1.5 Concepts and definitions of conditional probability, multiplication theorem $P(A \cap B) = P(A) \cdot P(B A)$</p> <p>1.6 Bayes' theorem.</p> <p>1.7 Concept and definition of independence of two events.</p> <p>1.8 Definition of random variable (r.v.), discrete and continuous random variable.</p> <p>1.9 Definition of probability mass function (p.m.f.) of discrete r.v. and Probability density function of continuous r.v.</p> <p>1.10 Cumulative distribution function (c.d.f.) of discrete and continuous r.v. and their properties. (Characteristic properties only)</p> <p>1.11 Definition of expectation and variance of discrete and continuous r.v., properties of expectation and variance.</p> <p>1.12 Scope and utility of R software</p> <p>1.13 technical know-how of R software</p> <p>1.14 getting help in R</p> <p>1.15 Data Frames Basics in R</p>		15

1.16	Computing basic statistical measures for raw data and grouped data using R software	
1.17	Numerical problems related to real life situations.	
Unit 2- Distributions and their properties		15
2.1 Binomial Distribution: definition, mean, variance, additive property, Bernoulli distributions a particular case with $n = 1$, moment generating function. Poisson Distribution: definition, mean, variance, moment generating function.		
2.2 Exponential Distribution: statement of probability mass function of the Form $f(x) = (1/\theta) e^{-x/\theta}$, mean, variance, nature of probability curve, lack of memory property. (with proof)		
2.3 Uniform Distribution: statement of probability distribution function, mean, variance, nature of probability curve.		
2.4 Normal Distribution: statement of probability density function, identification of parameters, nature of probability density curve, standard normal distribution, symmetry, computations of probabilities using normal probability table, normal approximation to binomial and Poisson distribution, central limit theorem (statement only).		
2.5 Fitting of Binomial, Normal and Poisson distribution using R software		
2.6 Numerical problems related to real life situations		
Unit 3 -Correlation and regression		15
3.1 Concept of bivariate data, scatter diagram, its interpretation, concept of Correlation, Positive correlation, negative correlation, zero correlation		
3.2 Karl Pearson's coefficient of correlation, properties of correlation coefficient, Interpretation of correlation coefficient, coefficient of determination with Interpretation.		
3.3 Concept of linear and nonlinear regression.		
3.4 Illustrations, appropriate situations for regression and correlation		
3.5 Linear regression: Fitting of both lines of regression using least square method. Concept of regression coefficients.		
3.6 Properties of regression coefficients		
3.7 Computing Correlation coefficient and lines of regression for a bivariate data using R software		
3.8 Numerical problems related to real life situations		
Unit 4 :- Hypothesis testing and ANOVA		15
4.1 Large Sample Tests Ho: $\mu = \mu_0$ Vs H1: $\mu \neq \mu_0$ (one sample test for mean) Ho: $\mu_1 = \mu_2$ Vs H1: $\mu_1 \neq \mu_2$ (two sample test for mean) Ho: $P = P_0$ Vs H1: $P \neq P_0$ (one sample test for propotion) Ho: $P_1 = P_2$ Vs H1: $P_1 \neq P_2$ (two sample test for propotion) Numerical problems related to real life situations.		
4.2 Test based on F- distribution F-test for testing significance of equality of two population variances		
4.3 Small Sample Tests Ho: $\mu = \mu_0$ Vs H1: $\mu \neq \mu_0$ (t-test for One Sample mean) Ho: $\mu_1 = \mu_2$ Vs H1: $\mu_1 \neq \mu_2$ (t-test for two Sample mean) Paired t-test for dependent samples.		
4.4 Tests based on Chi square distribution		
a. Chi-square test for goodness of fit		
b. Test for independence of attributes (mxn and 2x2)		
4.5 One way ANOVA		

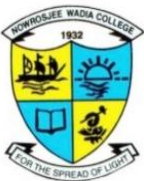
<p>4.6 Two way ANOVA 4.7 Tests based on t-distribution , chi- distribution using R software 4.8 ANOVA problems by using R software 4.9 Numerical problems related to real life situations.</p>	
References	<ol style="list-style-type: none"> 1. Probability and Statistics for Engineers and Scientists: Walpole, Myers, Myers Ye 2. Statistics: Murray R. Spiegel, Larry J. Stephens 3. Probability and Statistics for Engineers: Richard A. Johnson, C.B.Gupta 4. Statistics using R : Narosa Publishing house by Dr. S. G. Purohit, Dr. S. D. Gore, Dr. S. R. Deshmukh 5. Statistical Methods, George W. Snedecor, William G, Cochran, John Wiley &sons 6. Fundamentals of Mathematical Statistics(3rd Edition), Gupta S. C. and Kapoor V. K.1987 S. Chand and Sons, New Delhi 7. Introduction to Linear Regression Analysis, Douglas C. Montgomery, Elizabeth A. Peck,G. Geoffrey Vining, Wiley
Learning outcomes	<p>LO1: Summarize dada LO2: Apply probability techniques in a specific problem LO3: Apply a specific discrete probability distribution as model in a particular data situation LO4: Analyze a problem area and apply methods of descriptive Statistics LO5: Study and identify correlation between variables LO4: To fit an equation/model for prediction purposes and apply it for some real life data LO5: Apply these distributions as models in various situations LO6: Understand basic ideas of testing and apply various test procedures in actual applications LO7: To use R software basic commands in such analysis</p>

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
	Masters of Science (Industrial Mathematics with Computer Applications)	
Elective (Theory) Subject: SEMESTER – I		
Year – 1	Paper No: MIMMJ114B	Credits 4
Semester-I	Name of Paper: Software Engineering	Hours 60
Course specific outcomes- This course will enable the student to:		
CO1: Design various models to depict the development of an object-oriented software system.		
CO2: Design test cases of a software system.		
COURSE CONTENT/ SYLLABUS		Lectures
Unit 1- Introduction to Software Engineering, Software Process Models		10
2.1 Nature of Software		
2.2 Software Engineering Principles		
2.3 The Software Process		
2.4 Software Myths.		
2.5 Process Models: A Generic Process Model		
2.6 Prescriptive Process Models: The Waterfall, Incremental Pro		
2.7 cess (RAD), Evolutionary Process, Unified Process, Concurrent, Advanced Process Models & Tools: Agile software development: Agile methods, Plan-driven and agile development, Extreme programming Practices, Testing in XP, Pair programming.		
2.8 Introduction to agile tools: JIRA, Kamban.		
Unit 2 - Object Oriented Concepts and Principles		6
3.1 What is Object Orientation		
3.2 Introduction to an Object, Classes and Instance		
3.3 Polymorphism		
3.4 Inheritance		
3.5 Object Oriented System Development		
3.5.1 Introduction		
3.5.2 Function/Data Methods (With Visibility)		
3.5.3 Object Oriented Analysis		
2.5.4: Object Oriented Construction, Identifying the Elements of an Object Model, Identifying Classes and Objects, Specifying the Attributes (With Visibility) , Defining Operations Finalizing the Object Definition		
Unit 3- Introduction to UML		2
4.1 Concept of UML		
4.2 Advantages of UML		
Unit 4-Basic Structural Modelling		5
5.1 Classes		
5.2 Relationships		
5.3 Common Mechanisms		
5.4 Class Diagram		
Unit 5- Advanced Structural Modelling		7
6.1 Advanced Classes		
6.2 Advanced Relationship		
6.3 Interface, Types and Roles		
6.4 Packages		


6.5 Object Diagrams		
Unit 6-Basic Behavioral Modelling 7.1 Interactions 7.2 Use Cases and Use Case Diagram with stereo types 7.3 Interaction Diagram 7.4 Sequence Diagram 7.5 Activity Diagram, State Chart Diagram		9
Unit 7-Object Oriented Analysis 8.1 Iterative Development and the Rational Unified Process 8.2 Inception 8.3 Understanding Requirements 8.4 Use Case Model From Inception to Elaboration 8.5 Elaboration.		6
Unit 8- Object Oriented Design 9.1 The Generic Components of the OO Design Model 9.2 The System Design Process 9.2.1 Partitioning the Analysis Model 9.2.2 Concurrency and Sub System Allocation 9.2.3 Task Management Component 9.2.4 The Data Management Component 9.2.5 The Resource Management Component 9.2.6 Inter Sub System Communication 8.3 Object Design Process		4
Unit 9-Architectural Modelling 10.1 Component 10.2 Components Diagram 10.3 Artifacts of the system & Artifact diagram 10.4 Deployment Diagram 10.5 Collaboration Diagram		6
Unit 10- Object Oriented Testing 2.1 Object Oriented Testing Strategies 2.2 Test Case Design for Object Oriented Software 2.3 Inter Class Test Case Design		5
References	<ol style="list-style-type: none"> 1. Roger Pressman, —Software Engineering: A Practitioner ‘s Approachll, McGraw Hill, ISBN 0–07–337597–7 2. Ian Sommerville, — Software Engineeringll, Addison and Wesley, ISBN 0-13-703515- 3. Grady Booch, James Rumbaugh, ”The Unified Modeling Language User/Reference Guide”, Pearson Education INC 4. Ivar Jacobson, “Object Oriented Software Engineering”, Pearson Education INC 5. Craig Larman, “Applying UML and Patterns”, Pearson Education INC 6. Bennett, Simon, ” Object Oriented Analysis and Design” McGraw Hill 	
Learning outcomes	After the course the student will be able to: LO1: Construct appropriate UML diagram for system LO2: Identify Objects, classes, relationship among them. LO3: Understand software tools, test cases used in system. LO4: Understand Agile, JIRA, Kamban etc.	

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
	Masters of Science (Industrial Mathematics with Computer Applications)	
Research Methodology		
Year -1	Paper No: MIMMJ116	Credits -4
Semester-I	Name of Paper: Research Methodology	Hours 60
<p>Course specific outcomes- This course will enable student to:</p> <p>CO1: Develop skills in qualitative and quantitative data analysis and presentation CO2: Comprehend and explain research articles in their academic discipline. CO3: Demonstrate the ability to choose methods appropriate to research problems. CO4: Take up and implement a research project or study. CO5: Collect the data, edit it properly and analyze it accordingly. CO6: Learn Typesetting of journal articles, technical reports, thesis, books, and slide presentations using Latex.</p>		
COURSE CONTENT/ SYLLABUS		
Unit 1: Foundation of research 1.1 Meaning and Objectives of research 1.2 Significance of research 1.3 Types of research, Characteristic of mathematical methods 1.4 Research process, Defining Research problem		12
Unit 2: Mathematical statements 2.1 If then statements, Sufficient and necessary conditions 2.2 Contrapositive, Converse, Negation 2.3 Direct and indirect proof, Principle of induction 2.4 Inductive reasoning, Counter examples		14
Unit 3: Research design and Method of Data Collection 3.1 Need for research design 3.2 Different research designs 3.3 Collection of data, observation method, Questionnaires 3.4 Numerical and graphical data analysis using software's		14
Unit 4: Preparation of thesis and Research papers 4.1 Guideline for writing the Abstract 4.2 Layout of the report, methodology, result and discussion 4.3 Style of referencing, Bibliography 4.4 Research Ethics, Software for detection of Plagiarism		10
Unit 5: Latex for Writing paper, Thesis, and Report 5.1 Introduction to Latex 5.2 Document structure 5.3 Mathematical Concepts		10


5.4 Inserting Reference, Presentation using Beamer	
References	<ol style="list-style-type: none"> 1. C.R. Kothari, Research methodology (second revised edition), New Age publishers, 2004. 2. James R. Munkres, Topology, Second edition, Prentice Hall of India, 2002. 3. Michael P. Marder, Research methods for science, Cambridge University press, 2011. 4. Bordens, K.S. and Abbott B. B., Research Design and Methods, A process approach, 8 Edition, McGraw-Hill, 2011
Learning outcomes	<p>After the completion of the course students will be able to:</p> <p>LO1: identify and discuss the complex issues inherent in selecting a research problem, selecting research design, and implementing research project.</p> <p>LO2: understand the fundamentals of logical reasoning in pure mathematics.</p> <p>LO3: write a research report and thesis.</p> <p>LO4: Develop the necessary skill to conduct, review and publish research.</p> <p>LO5: learn and understand the research publication ethics and tools like Latex.</p>

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
	Masters of Science (Industrial Mathematics with Computer Applications)	
Major (Theory) Subject: Mathematics SEMESTER – II		
Year - 1	Paper No: MIMMJ121	Credits 4
Semester-II	Name of Paper: Real Analysis	Hours 60
<p>Course specific outcomes- This course will enable the student to:</p> <p>CO1: Introduce concept of Metric spaces and there topological properties.</p> <p>CO2: Understand the consequences of various mean value theorems for differentiable functions.</p> <p>CO3: Calculate and examine the continuity of a function at a point.</p> <p>CO4: Understanding Numerical sequences and series.</p> <p>CO5: Apply the theory in the course to solve a variety of problems at an appropriate level of difficulty.</p>		
COURSE CONTENT / SYLLABUS		Lectures
<p>Unit 1- Metric Spaces and its Topology</p> <p>Metric Spaces Definition and Examples, k-cells, convex sets, open closed ball, properties, Definition: Neighborhood, limit point, isolated points, closed sets, interior points, open sets, perfect sets bounded sets, dense sets, examples and properties, Definition: Open cover, compact sets, examples and properties. Theorem of Weierstrass , Connected sets, definition of separated sets, connected sets and properties</p>		10
<p>Unit 2- Numerical Sequences and series</p> <p>Convergent Sequences, Definition and Examples Properties, Subsequences: Definition and properties, Cauchy Sequences: Definition, Examples and properties, Definition of complete metric space, examples, Definition of Monotonic Sequences and its properties, Upper and lower limits, Definition, examples and properties, Convergence of some special sequences, Series: Definition, examples and properties, series of non-negative terms, Cauchy's condensation test and examples, The Number e , Root and ratio tests, examples, Power series, Definition, radius of Convergence, examples and properties, Summation by parts, absolute convergence</p>		10
<p>Unit 3-Continuity</p> <p>Limits of functions: Definition, examples and properties, Continuous functions, Definition, examples and properties, Continuity and Compactness, Bounded Set: Definition, Continuous image of a compact set is compact and related properties, Definition of Uniform Continuity and related properties, Continuity and Connectedness: continuous image of connected set is connected and related properties, Discontinuities, Definition, examples, Monotonic functions, Definition examples and properties</p>		14
<p>Unit 4-Differentiation</p> <p>Derivative of a real function, Definition examples and properties, Mean Value Theorem, Continuity of derivatives, Taylor's Theorem , Differentiation of a vector valued function</p>		6

Unit 5- Riemann Stieltjes Integral Definition and existence of the integral, related properties, Properties of the Integral, Integration and differentiation, Integration of vector valued functions	10
Unit 6- Sequences and series of functions Discussion of main problem- with examples, Uniform convergence: Definition and properties, Uniform convergence: and continuity, Uniform convergence: and integration, Uniform convergence: and differentiation	10
References	<ol style="list-style-type: none"> 1. Walter Rudin: Principles of Real Analysis, (3rd Edition, Tata McGraw Hill Publication) Art. 2.15 to 2.42, 2.45 to 2.47, Art. 3.1 to 3.46, Art. 4.1 to 4.18 4.19 (Statement only), 4.22 to 4.28, 4.29 (Statement only), 5.1 to 5.12, 5.15 to 5.19, 6.1 to 6.15, 6.20, to 6.25, Art 7.1 to 7.17. 2. C. C. Pugh, Real Mathematical Analysis. 3. T. M. Apostol, Mathematical Analysis 3. G. F. Simmons, Topology and Modern Analysis.
Learning outcomes	After the course the student will be able to: LO1: Calculate and examine the continuity of a function at a point. LO2: Understand the consequences of various mean value theorems for differentiable functions. LO3: Demonstrate an understanding of theory of sequences and series, continuity, differentiation, integration.


	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
Masters of Science (Industrial Mathematics with Computer Applications)		
Major (Theory) Subject: Mathematics SEMESTER – II		
Year -I	Paper No- MIMMJ122	Credits 4
Semester-II	Name of Paper - Algebra	Hours 60
<p>Course specific outcomes-The course will enable the students to:</p> <p>CO1: Recognize groups and classify them as abelian, cyclic etc</p> <p>CO2: Analyze consequences of Lagrange's theorem</p> <p>CO3: Learn about structure preserving maps between groups and their consequences</p> <p>CO4: Explain the significance of the notion of cosets, normal subgroups and factor groups</p> <p>CO5: Understand the fundamental concept of Rings, Fields, subrings, integral domains and the corresponding morphisms</p> <p>CO6: Learn in detail about polynomial rings</p> <p>CO7: Learn and appreciate the significance of unique factorization in integral domains</p>		
COURSE CONTENT/ SYLLABUS		Lectures
<p>Unit 1. Groups and permutations Binary Operation , Introduction to Groups, Examples and properties of Groups, Finite Groups, Subgroups, Cyclic Groups, Permutation Groups, Orbits, Cycles, Alternating Groups</p>		16
<p>Unit 2-Normal subgroups, Factor Groups and Homomorphisms Cosets and the Theorem of Lagrange, Direct Products, Normal Subgroups, Quotient/ Factor Groups, Factor Group Computations and Simple Groups, Group Homomorphisms, Isomorphisms, First Isomorphism Theorem, Cayley's Theorem, Sylow Theorems - only statements and problems</p>		14
<p>Unit 3-Rings, Factor rings Introduction to Rings, Subring, Fields, Divisors of zero, Integral Domain, Characteristic of a Ring, The Field of Quotients of an Integral Domain,. Ideals , Various Types of Ideals – Principal, Maximal, Prime Ideal, Homomorphism, Properties of Homomorphism , Isomorphism of Rings, Factor Ring, Fundamental Homomorphism Theorem.</p>		16
<p>Unit 4-Rings of Polynomials & Factorization Polynomials in an indeterminate, The Evaluation Homomorphism, Zeros, Factorization of a Polynomial over a Field: The Division Algorithm in $F[x]$, Irreducible Polynomials, Uniqueness of Factorization in $F[x]$, Unique Factorization Domain, Principal Ideal Domain, Gauss Lemma, $D[x]$ is a UFD, Euclidean Norm, Euclidean Domain, Euclidean Algorithm (Without Proof), Gaussian Integers, Multiplicative Norm.</p>		14


References	1) A course in Abstract Algebra, V. K. Khanna & S. K. Bhamri, 5th Edition, Vikas Publishing House 2) A First Course in Abstract Algebra, John B. Fraleigh, Seventh Edition, Pearson. 3) Joseph Gallian – Contemporary Abstract Algebra, Narosa Publishing House 4) I. N. Herstien, Topics in Algebra, John Wiley and Sons. 5) N.S. Gopalakrishnan, University Algebra, Second Edition, New Age International, New 6) Delhi, 1986. 7) 4. Joseph. A. Gallian, Contemporary Abstract Algebra, (4th Edition), Narosa Publishing House.
Learning outcomes	After the course the student will be able to: LO1: Understand and use the properties of groups LO2: Link the fundamental concepts of groups and symmetries of geometrical objects. LO3: Explain the significance of the notions of cosets, normal subgroups, factor groups. LO4: Analyse consequences of Lagrange’s theorem

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
	Masters of Science (Industrial Mathematics with Computer Applications)	
Major (Theory) Subject: SEMESTER – II		
Year - 1	Paper No: MIMMJ123	Credits 4
Semester-II	Name of Paper: Data Structure and Core JAVA	Hours 60
Course specific outcomes- This course will enable the student to:		
CO1: know the types of data structure.		
CO2: Operations performed on data structure.		
CO3: Way of storing and retrieving data		
CO5: Understand concepts of OOP		
CO6: Understand concepts of-Object, Class		
CO7: Understand basics of JAVA Programming		
Section-I: Data Structure		
Section -II: Core JAVA		
COURSE CONTENT/ SYLLABUS:-		
Section-I: Data Structure-		Lectures
Unit 1-Introduction to data Structure		3
1.1 Data, Data types, Abstract Data Type		
1.2 Data Structures		
1.3 Linear & Nonlinear data structures		
1.4 Algorithm Analysis		
Unit 2 – Stack		4
2.4 ADT, Push and Pop operations		
2.5 Stack implementation using array		
2.6 Stack applications		
2.7 Infix to postfix conversion of expression		
2.8 Expression evaluation		
2.9 Recursion		
Unit 3- Queue		4
3.1 ADT, Insert and Delete operations		
3.2 Queue implementation using array		
3.3 Types –Priority Queue, Circular queue, Dequeue		
3.4 Queue applications		
Unit 4- Linked List		6
4.1 Linked List Concept,		
4.2 Operations: Insert, Delete, Traversal		
4.3 Static implementation using arrays		

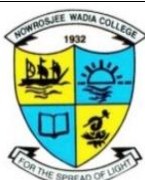
4.4 Dynamic implementation Doubly Linked list 4.5 Circular list Linked list applications: Stacks and Queues as Linked Lists 4.6 Merging of two linked lists	
Unit 5-Tree 5.1 Terminology and Concepts 5.2 Binary Tree Representation 5.3 Static implementation using arrays 5.4 Linked representation 5.5 Binary Search Tree 5.6 Operations on Binary search tree -Insert, Delete 5.7 Tree Traversals 5.8 Representing General Trees as binary tree	5
Unit 6-Sorting 6.1 Sorting Concept and need, 6.2 Techniques of Sorting, Need, Performance criteria 6.3 Techniques Comparison Based-(Bubble, Quick, Insertion, Merge) 6.4 Heap Sort 6.5 Linear order sorting-(Counting)	5
Unit 7- Graph 7.1 Graphs Terminology and concepts 7.2 Graph Representation: Adjacency matrix, Adjacency list, Adjacency multilist 7.3 Traversals: Depth first and Breadth first.	3
Data Structure -Reference Books: 1. Tanenbaum, Langsam, Augenstein: "Data structures using C", PHI 1994 2. D. Samanta: "Classic Data Structures", PHI 2002	
Section-II:- Core JAVA	
Unit 8- Introduction to JAVA-Object Oriented Concepts 8.1 Object, Class 8.2 Encapsulation, Abstraction, Data Hiding, Inheritance, Polymorphism, 8.3 Message Passing, Dynamic binding 8.4 History of Object-Oriented languages 8.5 Comparison with structured programming. 8.6 Introduction to The JAVA Technology 8.7 The JAVA platform, JAVA buzzwords, API, JVM 8.8 JAVA compiler, bytecodes	5
Unit 9-Main features of JAVA language 9.1 Introduction to JAVA, Writing & compiling JAVA programs- the main method 9.2 Command line arguments, 9.3 String class, 9.4 Primitive data types, Variables and assignment, JAVA doc comments 9.5 Expressions, Data conversion, Interactive programs, Boolean data type and expressions 9.6 { If, Switch } statements, { For, While, Do } statements, 9.7 Creating, calling methods, Parameter passing, Returning values, 9.8 Overloading methods, 9.9 Scope of variables. 9.10 Defining and initializing arrays, 9.11 new operator, using arrays 9.12 passing arrays to methods, returning arrays from methods	6

Unit 10-Objects and Classes 10.1 5. Defining Class, Creating object, 10.2 reference variables, 10.3 Visibility modifiers – public, private, protected 10.4 Object members and class members (static), 10.5 Arrays of objects, this keyword, Wrapper Classes	5
Unit 11- Packages and Interfaces 11.1. Concept of package, Package and import keywords 11.2. Concept of interfaces, Implementing interfaces 11.3 Use of predefined packages 11.4 Use of predefined interfaces – Comparable and Comparator	4
Unit 12- Inheritance and Polymorphism 12.1 Superclass and Subclass – extends keyword, super keyword, 12.2 Overriding members 12.3 Protected data members- Object Class and its toString() method, Abstract Classes 12.4 Final classes, methods and variables, instanceof operator 12.5 dynamic binding, Casting objects	6
Unit 13- Exceptions and Exception handling 12.6 Exception class hierarchy 12.7 Checked and unchecked exceptions 12.8 Try, catch, throw, throws finally keywords 12.9 Creating user defined exceptions	4
References	1. JAVA: How to Program, Deitel&Deitel, Prentice Hall 2. Core JAVA 2: Volume I – Fundamentals, Cay S. Horstmann and Gary Cornell; Prentice-Hall 2002. ISBN 0130471771 3. Core JAVA 2: Volume II – Advanced Features, Cay S. Horstmann and Gary Cornell; Prentice-Hall 2001. ISBN 0130927384 4. JAVA: The Complete Reference, Herbert Schildt. Fifth Edition 5. Introduction to JAVA Programming, Daniel Liang Important URLs : http://JAVA.sun.com/reference/docs
Learning outcomes	After the course the student will be able to: LO1: Create various data structure. LO2: Learn different ways of Traversal of data LO3: Apply OOP concepts in programming LO4: Apply Inheritance and polymorphism LO5: Do basic of JAVA Programming

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
Masters of Science (Industrial Mathematics with Computer Applications)		
Major (Practical) Subject: SEMESTER – II		
Year - 1	Paper No: MIMMJ125	Credits 2
Semester-I	Name of Paper: Practical based on Data Structure and Core JAVA	Hours 60
Course specific outcomes- This course will enable the student to: CO1: Apply the basic concepts of Object-oriented programming. CO2: Use the basics concepts Core JAVA. CO3: Data storing and retravel technique CO4: Sorting technique Implementation		
COURSE CONTENT/ SYLLABUS		
Section- I: Data Structure Lab 1- Practical based on Implementation of Stack. Basic operations on Stack 2 - Practical based on Implementation of Queue Basic operations on Queue, Circular Queue 3- Practical based on Implementation of Linked List Basic operations- Create, Merge, Traverse. Searching, delete and add element 4- Practical based on Sorting Technique (Bubbles sort, Quick Sort, Insertion sort, Merge sort) 5- Practical based Tree Implementation and Traversal Section- II: Core JAVA Lab 6- Practical based on Implementation OOPs concept 7 - Practical based on Basic of Core JAVA. 8- Practical based on Packages and Interface 9- Practical based on Inheritance 10- Practical based Exception Handling		
Learning outcomes	After the course the student will be able to: LO1: Create various data structure. LO2: Learn different ways of Traversal of data LO3: Understand OOP concepts LO4: Understand Inheritance and polymorphism LO5: Basics pf JAVA Programming	

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
Masters of Science (Industrial Mathematics with Computer Applications)		
Elective (Theory) Subject SEMESTER –II		
Year -1	Paper No: MIMMJ124A	Credits 4
Semester-II	Name of Paper- Computational Geometry	Hours 60
<p>Course specific outcomes- This course will enable the student to:</p> <p>CO1: Understand Two dimensional transformations</p> <p>CO2: Understand Three dimensional transformations</p> <p>CO3: Get acquainted with typical problem on Computational Geometry and existence solution</p> <p>CO4: Introduce projections and its types</p> <p>CO5: Explain Bezier curves.</p>		
COURSE CONTENT/ SYLLABUS		Hours
<p>Unit-1: Two dimensional transformation</p> <p>Introduction, Representation of points, Transformations and matrices, Transformation of points, Transformation of straight lines, Midpoint transformation, Transformation of parallel lines, Transformation of intersecting lines, Transformation: rotations, reflections, scaling, shearing, Combined transformations, Transformation of a unit square, Solid body transformations, Transformation and homogeneous coordinates. Translation, Rotation about an arbitrary point, Reflection through an arbitrary line, Projection – a geometric interpretation of homogeneous coordinates, Overall Scaling, Point at infinity.</p>		20
<p>Unit-2: Three dimensional transformations</p> <p>Introduction, Three dimensional – Scaling, shearing, rotation, reflection, translation, Multiple transformations, Rotation about – an axis parallel to coordinate axes, an arbitrary axis in space, Reflection through – coordinate planes, planes parallel to coordinate planes, arbitrary planes, Affine and perspective transformations, Orthographic projections, Axonometric projections, Oblique projections, Single point perspective transformations, Vanishing points</p>		20
<p>Unit-3: Plane Curves</p> <p>Introduction, Curve representation, Non – parametric curves, Parametric curves, Parametric representation of a circle and generation of circle, Parametric representation of an ellipse and generation of ellipse, Parametric representation of a parabola and generation of parabolic Segment, Parametric representation of a hyperbola and generation of hyperbolic segment</p>		12
<p>Unit-4: Space Curves</p> <p>Bezier Curves – Introduction, definition, properties, Curve fitting (up to $n = 3$), Equation of the curve in matrix form (upto $n = 3$)</p>		8


Reference Books	<ol style="list-style-type: none">1. D. F. Rogers, J. A. Adams, Mathematical elements for Computer graphics, Mc Graw Hill Intl Edition.2. Schaum Series, Computer Graphics. - M. E. Mortenson, Computer Graphics Handbook, Industrial Pres Inc
Learning outcomes	<p>This course will enable the students to:</p> <ol style="list-style-type: none">1. Construct algorithms for simple geometrical problems.2. Characterize invariance properties of Euclidean geometry by groups of transformations.3. Describe and construct basic geometric shapes and concepts by computational means

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
Masters of Science (Industrial Mathematics with Computer Applications)		
Elective (Theory) Subject SEMESTER – II		
Year - 1	Paper No: MIMMJ124B	Credits 4
Semester-II	Name of Paper- Data Analysis using Python	Hours 60
Course specific outcomes- This course will enable the student to: CO1: Understand the basic of Python Programming CO2: Writing logfile in Python CO3: Overview of OOP CO4: Understand the Database interaction		
COURSE CONTENT/ SYLLABUS		Lectures
Unit 1- UNIT 1. Introduction To Python 1.6 History of Python 1.7 Features of Python 1.8 Python Identifiers, Keywords and Indentation 1.9 Comments and document interlude in Python 1.10 Command line arguments 1.11 Getting User Input 1.12 Python Data Types 1.13 Python variables 1.14 Python Core objects and Functions		8
Unit 2 - Control Flow, Functions, Modules And Packages 2.1 Control Flow 2.2 Conditional blocks using if else and elif 2.3 Simple for and while loops in python, For loop using ranges, string, list and dictionaries, Loop manipulation using pass, continue, break and else Functions, Arguments 2.4 Lambda Expressions, Function Annotations Modules Organizing python projects into modules 2.5 Importing own module as well as external modules, Packages, Programming using functions, modules and external packages		10
Unit 3- Data Structures 3.1 Lists as Stacks 3.2 Queues 3.5 Comprehensions Tuples and sequences Sets Dictionaries		3


<p>Unit 4-Python File Operation</p> <p>4.1 Reading config files in python</p> <p>4.2 Writing log files in python, Understanding read functions read(), readline() and readlines()</p> <p>4.3 Understanding write functions, write() and writelines()</p> <p>4.4 Manipulating file pointer using seek Programming using file operations</p>	8
<p>Unit 5- Object Oriented Programming</p> <p>5.1 Overview of OOP</p> <p>5.2 Creating Classes and Objects</p> <p>5.3 Accessing attributes, Built-In Class Attribute</p> <p>5.4 Destroying Objects</p>	5
<p>Unit 6- Regular Expression</p> <p>6.1 Powerful pattern matching and searching</p> <p>6.2 Power of pattern searching using regex Real time parsing of networking or system data using regex</p> <p>6.3 Password, email, url validation using regular expression</p> <p>6.4 Pattern finding programs using regular expression</p>	7
<p>Unit 7-Database Interaction SQL</p> <p>7.1 Database connection using python</p> <p>7.2 Creating and searching tables Reading and storing config information on database</p> <p>7.3 Programming using database connections</p>	4
<p>Unit 8-Python for Data Analysis</p> <p>8.1 Numpy: Introduction to numpy Creating arrays Using arrays and Scalars Indexing Arrays Array Transposition Universal Array Function Array Processing Array Input and Output</p> <p>8.2 Pandas: What are pandas? Where it is used? Series in pandas Index objects Re index Drop Entry Selecting Entries Data Alignment Rank and Sort Summary Statics Missing Data Index Hierarchy</p> <p>8.3 Matplotlib: Python for Data Visualization Welcome to the Data Visualization Section Introduction to Matplotlib</p>	10
<p>Unit 9- Django Web Framework in Python</p> <p>9.1 Introduction to Django</p> <p>9.2 Introduction to Full Stack Web Development</p>	5
References	<ol style="list-style-type: none"> 1. Learning Pyhon, O “Really Publication 2. Programming Pyhon, O” Really Publication 3. Python for Everybody: Exploring data using Python3 by Dr. Charles R. Severance 4. https://docs.python.org/3/tutorial/ https://www.datacamp.com/community/tutorials/beginner-guide-google-vision-api
Learning outcomes	<p>After the course the student will be able to:</p> <p>LO1: Write Python Program</p> <p>LO2: Can use python with SQL interaction</p> <p>LO3: Apply in Data Analysis</p> <p>LO4: Understand fundamental programming concepts and methodology.</p> <p>LO5: Understand Pandas and Matplotlib</p>

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
Masters of Science with Major in Industrial Mathematics with Computer Applications		
Major (Theory) Subject: Mathematics SEMESTER – III		
Year –II	Paper No: MIMMJ231	Credits 4
Semester-III	Name of Paper: Design and Analysis of Algorithms	Hours 60
<p>Course specific outcomes- This course will enable the student to:</p> <p>CO1: develop a solid foundation in algorithm analysis, including growth functions, summations, recurrences, and counting techniques</p> <p>CO2: familiarize students with fundamental sorting algorithms and their time complexities, such as insertion sort, heap sort, and merge sort.</p> <p>CO3: understand and apply the divide and conquer strategy to solve problems, including binary search, merge sort, quick sort, and Strassen's matrix multiplication.</p> <p>CO4: explore greedy algorithms and their applications in solving optimization problems, such as the fractional knapsack problem, job sequencing, minimum-cost spanning trees, and Huffman coding</p> <p>CO5: introduce dynamic programming as a problem-solving technique, covering topics such as matrix chain multiplication, longest common subsequence, 0/1 knapsack problem, and all pairs shortest path</p>		
COURSE CONTENT/ SYLLABUS		Lectures
Unit 1- Unit 1. Introduction 1.1 What is an Algorithm? 1.2 Algorithm Specification 1.3 Performance Analysis		10
Unit 2- Divide and Conquer 2.1 General Method 2.2 Binary Search 2.3 Finding the Maximum and Minimum 2.4 Merge Sort 2.5 Quick Sort- Performance Measurement 2.6 Strassen's Matrix Multiplication 2.7 Convex Hull- Some Geometric Primitives, the QuickHull Algorithm, Graham's Scan.		18
Unit 3- The Greedy Method 3.1 The General Method		18


<p>3.2 Knapsack Problem 3.3 Tree Vertex Splitting 3.4 Job Sequencing with Deadlines- Prim's Algorithm, Kruskal's Algorithm. 3.5 Optimal Storage of Tapes 3.6 Optimal Merge Patterns 3.7 Single-Source Shortest Paths</p>	
<p>Unit 4- Dynamic Programming 4.1 The General Method 4.2 String Editing 4.3 0/1-Knapsack 4.5 Matrix Chain Multiplication Problem.</p>	14
References	<p>1. Computer Algorithms, E. Horowitz, S. Sahni, S. Rajasekaran, Computer Science Press, (1998). (1.1, 1.2, 1.3, 3.1, 3.2, 3.3, 3.4, 3.5.1, 3.7, 3.8.1, 3.8.2, 3.8.3, 4.1, 4.2, 4.3, 4.4, 4.5.1, 4.5.2, 4.6, 4.7, 4.8, 5.1, 5.6, 5.7) 2. Introduction to Algorithms, T. H. Cormen, C.E. Leiserson, R.L. Rivest, C. Stein, Prentice-Hall of India Private Limited; Indian Edition (2nd Edition) edition (2003). (15.2 Matrix Chain Multiplication Problem) 3. Algorithm Design. Jon Kleinberg and Eva Tardos. Addison Wesley, 2005.</p>
Learning outcomes	<p>After the course the student will be able to: LO1: calculate time complexities and space complexities for various programs. LO2: use divide and conquer algorithm for various types of sorting problems. LO3: apply Greedy techniques to obtain solutions of various problems. LO4: basic idea of dynamic programming.</p>


	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
Masters of Science with Major in Industrial Mathematics with Computer Applications		
Major (Theory) Subject SEMESTER – III		
Year – II	Paper No- MIMMJ232 Name of Paper- Advanced Java	Credits 2T+ 2P
Semester-III		Hours 60
Course Specific Outcomes: On completion of the course, the students will CO1: Understand the concepts related to Java Technology. CO2: Create Dynamic Web Pages using Servlet and JSP. CO3: Use the advanced concepts of Java. CO4: Graphics and Multithreading technique CO5: Data retrieval and apply different collections		
COURSE CONTENTS/ SYLLABUS		Lectures
Unit 1- Multithreading 1.1 What Are Threads 1.2 Running and Starting Thread 1.3 Running Multiple Threads 1.4 The Run able Interface 1.5 Thread Priorities 1.6 Synchronization and inter Thread Communication.		11
Unit 2- Database Programming 2.1 JDBC Design and Configuration Details 2.2 Types of Drivers 2.3 Query Building and Execution 2.4 Result sets, Row Sets 2.5 (Implementation of Case study)		9
Unit 3- Collections 3.1 Introduction to Collection Framework 3.2 (interfaces, implementation and algorithms), Interfaces, Collection Classes: Set, List, Queue and Map 3.4 Set: Hash Set, Tree Set, Linked Hash Set 3.5 Interfaces Such as Lists, set, vectors, linked List, Comparator, Iterator, Hash Tables		10
Unit 4- Servlet 4.1 Introduction To Servlet(HTTP servlet) 4.2 Life cycle of Servlet 4.3 Handling GET and POIST request(HTTP) 4.4 Data Handling using Servlet 4.5 Creating Cookies		8

4.6 Session tracking		
Unit 5- JSP and Java Frameworks 5.2 JSP Basics 5.2 Getting Familiar with JSP Server 5.3 Java Frameworks Basics- Introduction, Types, Framework Vs Library Vs API 5.4 Spring Framework- Overview, Architecture, Advantages		7
Unit 6- Networking 6.1 The JAVA.NET package 6.2 Connection Oriented Transmission- Stream Socket class 6.3 Creating a socket to a remote post on a port 6.4 Simple socket program, Examples		9
Practical on Advanced JAVA: - Practical 1: Graphics Programming Practical 2: Multithreading Practical 3: Database Programming Practical 4: Collections		30 Hours
References:	1. Java The Complete Reference by Herbert Schildt McGraw Hill Education 2. Java Black Book by Steven Holzner Dreamtech Press 3. Professional Java, TM Development with the Spring Framework by Rod Jhnson, Juergen Hoeller, AlefArendsen, Thomas Risberg, Colin Sampaleanu Wiley Publishing	
Learning Outcomes	LO1: Create various Applets. LO2: Use of threads LO3: Understand OOP concepts using advanced java techniques LO4: Understand database operating LO5: Utilization of different collections in Java	

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
Masters of Science with Major in Industrial Mathematics with Computer Applications		
Major (Theory) Subject SEMESTER – III		
Year – II	Paper No- MIMMJ234	Credits 2
Semester-III	Name of Paper- Computer Networks	Hours 60
Course specific outcomes- This course will enable the student to understand: CO1. This course can help learners to know basic components of an operating system. CO2. This course helps to Understand fundamental operating system abstractions such as processes, threads, files, semaphores, memory Management etc. CO3. This course helps learners to solve problems on CPU scheduling, disk scheduling, memory management. CO4: Basics of networking, Data communication concepts, protocols and standards CO5: Applications of network. CO6: Network Models-ISO-OSI Model and its protocol stack.		
COURSE CONTENT / SYLLABUS		Lectures
UNIT 1- Introduction to Computer Networks 1.1 Introduction to Computer Network , Application 1.2 Definition of Protocol and Protocol Standards (De facto and De jure) 1.3 Data Flow and Its Types (Simplex, Half Duplex and Full Duplex) 1.4 Types of Computer Network (LAN, WAN, MAN, PAN) 1.5 Network Topologies (Point to Point, Bus, Mesh, Ring, Star, Tree, Hybrid) 1.6 Reference models - OSI, TCP/IP Reference model, Comparison of OSI and TCP/IP Reference Model		8
UNIT 2- Physical Layer 2.1 Data and Signals: Analog and Digital signals, Transmission Impairment, Data Rate Limits, Performance. 2.2 Data Transmission Media: Guided Media, Unguided Media and Satellites 2.3 Bandwidth Utilization: Multiplexing and Spreading 2.4 Switching: Circuit switching, Message switching & Packet switching.		6
UNIT 3- Data Link Layer: 3.1 Data Link Control: Framing, Flow and Error Control, Error Detection and Correction. 3.2 Data Link Layer Protocols-High-Level Data Link Control (HDLC) & Point-to-Point protocol (PPP) 3.3 Wired LAN and Wireless LAN		4
UNIT 4- Network Layer 5.1 Virtual Circuits and Datagram Subnets, Addresses: Address Space, Notations, Classful addressing, Classless addressing, Subnetting and Network Address Translation (NAT) 5.2 Network Layer Protocols- IP, IPV4 and IPV6		6


UNIT 5- Transport Layer and Application Layer		6
5.1 Process-to-Process Communication, addressing: Port Numbers, Encapsulation and Decapsulation, Multiplexing and Demultiplexing, Flow Control, Error Control, Congestion Control		
5.2 Transport Layer protocols-TCP & UDP 5.3 Application Layer Protocols: HTTP, HTTPS, FTP, SMTP, DNS		
References	1. Modern Operating system by Tanenbaum, PHI Publication 2. Computer Networks-Andrew S. Tanenbaum, 5th Edition, Pearson Education. 3. Data Communication and Networking- Behrouz Fourouzan, 5th Edition, McGraw Hill Pvt. Ltd.	
Learning outcomes	After the course the student will be able to: LO1. Understand the networking topology and data communication concepts. LO2. Understands the Network Model ISO-OSI Model LO3. Application of network.	

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
Masters of Science with Major in Industrial Mathematics with Computer Applications		
Major (Practical) Subject SEMESTER – III		
Year-II	Paper No- MIMMJ235	Credits 2
Semester-III	Name of Paper- Lab on Data Science	Hours 60
Course specific outcomes- This course will enable the student to: CO1: Basic concept of data Science CO2: Introducing AI Basics CO3: Implementation of Data Science and AI Concept		
COURSE CONTENTS/ SYLLABUS		
<ol style="list-style-type: none"> 1. Practical based on Introduction to Python for Data Science 2. Practical based on Data Cleaning and Manipulation 3. Practical based on Machine Learning 4. Practical based on Basic Data Analytics 5. Practical based on Data Visualization 6. Practical based on AI & Problem solving 		
Learning Outcomes:	After the course the student will be able to: LO1: Understand Data Science and AI concepts LO2: Able to implement the AI concept Programmatically.	


	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
Masters of Science with Major in Industrial Mathematics with Computer Applications		
Elective (Theory) Subject SEMESTER – III		
Year – II	Paper No- MIMMJ236-A Name of Paper- Numerical Analysis	Credits 4= 2T+2P
Semester-III		Hours 90
<p>Course specific outcomes- This course will enable the student to: CO1: To solve problems numerically by various approximation methods. CO2: To find the approximate area of some complex regions using Numerical Integration. CO3: Demonstrate understanding of common Numerical Methods and how they are used to obtain approximate solutions. CO4: Perform an error analysis for various numerical methods CO5: Derive appropriate numerical methods to calculate a definite integral CO6: Analyze the error incumbent in any such numerical approximation. CO7: Study different techniques of interpolation CO8: Write computer programs to solve engineering problems with MATLAB/maple and/or C Language</p>		
COURSE CONTENT / SYLLABUS		Lectures
Unit 1- Iterative solutions of Nonlinear Equations 1.1 Bisection Method 1.2 Fixed-Point iteration 1.3 Newton's method 1.4 Secant method 1.5 Regula falsi method		5
Unit 2- Polynomial Interpolation 2.1 The Lagrange interpolation polynomial 2.2 Divided difference interpolation 2.3 Newton Forward interpolation 2.4 Newton Backward interpolation		5
Unit 3- Systems of Linear equations 3.1 Gauss elimination with partial pivoting 3.2 Matrix factorization methods (Doolittle reduction, Crout reduction)		5

3.3 Iterative techniques 3.4 Gauss-Jacobi iteration 3.5 Gauss-Seidel iteration	
Unit 4- Numerical Calculus 4.1 Numerical differentiation 4.2 Forward difference Quotient 4.3 Central difference quotient 4.4 Newton cotes formula 4.5 trapezoidal rule and Simpson's rule	7
Unit 5- Numerical solution of Differential Equations 5.1 Euler's method 5.2 Modified Euler's method 5.3 Runge-Kutta method 5.4 Runge-Kutta methods for systems of equations.	5
Unit 6- The Eigen value problem 6.1 Power method 6.2 Eigen values of symmetric matrices 6.3 Jacobi method	3
Practical on Numerical Analysis: - 1) Practical on Bisection Method, Fixed-Point iteration, Newton's method. 2) Practical on Secant method and Regula false method. 3) Practical on Lagrange interpolation polynomial and Divided difference interpolation. 4) Practical on Newton Forward interpolation and Newton Backward interpolation. 5) Practical on Gauss elimination with partial pivoting, Matrix factorization methods (Doolittle reduction, Crout reduction), Iterative techniques. 6) Practical on Gauss-Jacobi iteration and Gauss-Seidel iteration. 7) Practical on Numerical differentiation, Forward difference Quotient, Central difference quotient 8) Practical on trapezoidal rule, Simpson's $1/3^{\text{rd}}$ rule and Simpson's $3/8$ rule. 9) Practical on Euler's method and Modified Euler's method. 10) Practical on Runge-Kutta method and Runge-Kutta methods for systems of equations. 11) Practical on Eigen values, eigen vector and Power method. 12) Practical on Eigen values of symmetric matrices and Jacobi method	60 hours
References:	1. John H. Mathews: Numerical Methods for Mathematics, Science and Engineering (Prentice- Hall) 2nd Edition. Sections: 1.3, 2.1 to 2.7, 3.4 to 3.7, 4.2 to 4.4, 6.1 to 6.2, 7.1 to 7.4, 9.2 to 9.7, 11.1 to 11.2 2. K. E. Atkinson: An introduction to Numerical Analysis (John Wiley Sons). 3. S. Sastry: Numerical Analysis


	<p>4. W. H. Press, B. P. Flannery, S. A. Teukolsky, W. T. Vetterling, "Numerical Recipes in C", Cambridge University Press, 1st edition, 1988.</p> <p>5. M. Pal, Numerical Analysis for Scientists and Engineers: Theory and C Programs, Narosa, 2008.</p>
Learning outcomes:	<p>After the course the student will be able to:</p> <p>LO1: solve the algebraic and transcendental Equation.</p> <p>LO2. solve the linear system of equation using different numerical methods.</p> <p>LO3. To understand the interpolation techniques.</p> <p>LO4. To able to integrate the functions using Numerical Methods.</p> <p>LO5. To solve the various differential equations using Numerical Methods.</p> <p>LO6: implement numerical methods in MATLAB</p> <p>LO7: use approximation algorithm in real world problem</p>

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
	Masters of Science with Major in Industrial Mathematics with Computer Applications	
Major (Theory) Subject: Mathematics SEMESTER – IV		
Year –II	Paper No: MIMMJ241	Credits 4
Semester-IV	Name of Paper: Operations Research	Hours 90
<p>Course specific outcomes- This course will enable the student to: CO1: Formulate real life problems into linear programming problem. CO2: Understand the importance of sensitivity analysis in managerial decision making. CO3: Analyze the effect of variations in input data of linear programming problem through sensitivity analysis. CO4: Understand the importance of duality in linear programming problem. CO5: Understand transportation model and will be able to find Initial Basic Feasible Solution and optimal transportation cost. CO6: Understand assignment models. CO7: Use the quadratic programming models for real life problems.</p>		
COURSE CONTENT/ SYLLABUS		Lectures
Unit 1: Linear Programming Problem (LPP) 1.1 Standard form of LPP 1.2 Simplex method 1.3 Big-M method 1.4 Types of linear programming solutions 1.5 Duality in LPP, Primal-Dual Relationship 1.6 Solution of Primal LPP using dual LPP		15
Unit 2: Sensitivity Analysis in Linear Programming 2.1 Changes in objective function coefficients 2.2 Changes in availability and resources 2.3 Changes in the input-output coefficients		10
Unit 3: Integer Linear Programming 3.1 Types of Integer Programming Problems 3.2 Gomory's all integer cutting plane method 3.3 Gomory's mixed- integer cutting plane method 3.4 Branch and Bound Method		10


<p>Unit 4: Transportation Model and Its Variants</p> <p>4.1 Transportation Model</p> <p>a) Definition of Transportation Problem</p> <p>b) Types of Transportation problem - unbalanced and balanced</p> <p>4.2 Initial Basic feasible solutions</p> <p>4.3 Optimum Solutions by MODI method</p> <p>4.4 The Assignment Model and its solutions</p>	15
<p>Unit 5: Non-Linear Programming Problem</p> <p>5.1 The general non-linear programming problem</p> <p>5.2 Graphical solution method</p> <p>5.3 Quadratic Programming - Kuhn-Tucker Conditions</p>	10
References	<p>1. J. K. Sharma, Operations Research, (Third Edition, Macmillan India Ltd.), 2008.</p> <p>2. Hamdy A. Taha, Operations Research, (Eighth Edition, Prentice Hall of India), 2008.</p> <p>3.P. K. Gupta and D. S. Hira, Operations Research, (Fifth Edition, S. Chand), 2014.</p>
Learning outcomes	<p>After the course the student will be able to:</p> <p>LO1: apply methods to solve Integer programming problems and analysis of the solutions.</p> <p>LO2: understand the effect of variations in input data through sensitivity analysis.</p> <p>LO3: analyse the primal-dual relationship of a linear programming problem and compute the dual.</p> <p>LO4: understand techniques and methods to solve Transportation problems and Assignment problems.</p> <p>LO5: understand the concept of Non-linear programming and methods of solving the Non-linear programming problems.</p>

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
Masters of Science with Major in Industrial Mathematics with Computer Applications		
Elective (Theory) Subject SEMESTER – IV		
Year – II	Paper No- MIMMJ242 Name of Paper-Ordinary Differential Equations	Credits 2T+2P
Semester-IV		Hours 60
Course specific outcomes- This course will enable the student to: CO1: understand the concept of different types of differential equations. CO2: introduce various types of methods to solve differential equations. CO3: learn and apply the method to solve first order partial differential equations. CO4: introduce and solve higher order partial differential equations.		
COURSE CONTENT / SYLLABUS		Lectures
Unit 1- Introduction 1.1 Preliminaries of ODE and PDE 1.2 Existence and uniqueness theorems 1.3 Existence of independent solutions 1.4 Wronskian, Abel's formula 1.5 Singular solutions of first order ODEs		16
Unit 2- Ordinary Differential Equations 2.1 General theory of homogeneous and non-homogeneous linear differential equation 2.2 Regular and singular points 2.3 Power series solution of differential equation at regular and irregular singular points 2.4 Bessel's and Legendre's equations and their solutions		17
Unit 3- First order Partial Differential Equations 3.1 Curves and surfaces in three dimensions origin of PDEs 3.2 Lagrange's method 3.3 Orthogonal surfaces 3.4 Charpit's method and Jacobi method 3.5 Special types of first order PDEs 3.6 Cauchy problem for first order PDEs.		17
Unit 4- Higher order Partial differential Equations		10


<p>4.1 Solutions of higher order linear PDEs 4.2 Canonical form and reduction to canonical form.</p>	
<p>References:</p>	<ol style="list-style-type: none"> 1. Simmons, G. F. Differential Equations with Applications and Historical Notes. 2nd edition, Tata McGraw Hill, New Delhi, 2016. 2. Evans, L. C. Partial Differential Equations. 2nd edition, The Orient Blackswan, 2014. 3. Lebedev, N. N. Special Functions and Their Applications. Revised, Courier Corporation, 2012. 4. Ross, S. L. Differential Equations. 3rd edition, Wiley India, 2007. 4. Sneddon, I. N. Elements of Partial Differential Equations. Dover Publications, 2006. 5. Bell, W. W. Special Functions for Scientists and Engineers. Courier Corporation, 2004. 6. Raisinghania, M. D. Advanced Differential Equations. S. Chand & Company Ltd., New Delhi, 2001. 7. Reid, W. T. Ordinary Differential Equations. John Wiley and Sons, New York, 1971. 8. E. A. Coddington, An Introduction to Ordinary Differential Equations (Prentice- Hall).
<p>Learning outcomes</p>	<p>After the course the student will be able to:</p> <p>LO1: understand ordinary differential equations of various types, their solutions and fundamental concepts about their existence.</p> <p>LO2: apply various power series methods to obtain series solutions of differential equations.</p> <p>LO3: solve the first-order linear and non-linear PDE's by using Lagrange's, Charpit's method and Jacobi's method respectively and understand Cauchy problem for first order PDE's.</p> <p>LO4: Determine the solutions of linear PDE's of second and higher order with constant coefficients.</p>

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
	Masters of Science with Major in Industrial Mathematics with Computer Applications	
Major (Theory) Subject SEMESTER – IV		
Year – II	Paper No- MIMMJ 243 Name of Paper- Artificial Intelligence and Machine Learning	Credits 4=2T+2P
Semester-IV		Hours 90
<p>Course specific outcomes- This course will enable the student to: CO1: To understand the concept of machine learning. CO2: To interpret the different supervised classification methods of support vector machine and tree based models. CO3: To learn the different models of neural network for solving non-linear function. CO4: To acquire the knowledge of different generative models through unsupervised learning.</p>		
COURSE CONTENT / SYLLABUS		Lectures
Unit 1- Introduction of AI: 1.1 Concept-Artificial Intelligence, History of AI, Evolution of AI, Application of AI 1.2 Types of AI, Ethics Of AI. 1.3 AI Problems, Problem Formulation 1.4 Intelligent Agents, Types of Agents, Agent Environments, PEAS representation for an Agent, Architecture of Intelligent agents.		4
Unit 2- Introduction to ML 2.1 Machine Learning basics, Applications of ML, 2.2 Data Mining Vs Machine Learning vs Big Data Analytics, Limitation of ML 2.3 History and relationships to other fields 2.4 Types Of ML 2.5 Types of ML algorithms		4
Unit 3- Advance ML 3.1 Supervised Learning 3.2 Classifying with k-Nearest Neighbour classifier, 3.3 Decision Tree classifier, Naive Bayes classifier. 3.4 Unsupervised Learning - Grouping unlabelled items using k-means clustering, 3.5 Introduction to reinforcement learning.		6
Unit 4- Forecasting and Learning Theory: 4.1 Non-linear regression, Logistic regression, Randomforest, 4.2 Bayesian Belief networks, 4.3 Bias/variance trade off, Tuning Model Complexity		6

<p>4.4 Model Selection Dilemma. 4.5 Support Vector Machine (SVM), SVM- Algorithm 4.6 Kernel Machines & Ensemble Methods: Introduction, (self-Study)</p>	
<p>Unit 5- Artificial Neural Networks 5.1 Introduction 5.2 Activation Function, Optimization algorithm Gradient decent, Networks Perceptions-single layer & double layer 5.3 Backpropagation (BP), Network Algorithms Training Procedures 5.4 Type of ANN.</p>	5
<p>Unit 6- Deep Learning 6.1 Introduction to Convolution Neural Network (CNN), 6.2 Properties of CNN, Architecture of CNN 6.3 Introduction to Recurrent Neural Network (RNN), Sequential Processing 6.4 LSTM, Language Modelling, image captioning, Application of RNN. 6.5 Application of Deep learning</p>	7
<p>Practical on AI and ML 1. Practical on Python Basics (Practice assignment) 2. Search algorithms 3. Data Pre-processing 4. Regression models 5. Classification models 6. Clustering models</p>	Hours 60
References:	<ol style="list-style-type: none"> 1. Foundations of Neural Networks, Fuzzy system by Nikola k. Kasabov, MIT press Understanding Machine Learning. Shai Shalev-Shwartz and shai Ben David. Cambridge University press. 2. Neural network and Learning Machines, Simon Haykin, PHI Learning
<p>Learning Outcomes: After learning this course, students would be able to, LO1: Recognize the characteristic of machine learning that makes it useful to real world problems and apply different dimensionally reduction techniques. LO2: To apply the different supervised learning methods of SVM and tree-based models. LO3: To Model and solve computing problem using ANN. LO4: Specify, manipulate and apply CNN and RNN to solve diversified complex and real-world problem.</p>	

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
Masters of Science with Major in Industrial Mathematics with Computer Applications		
Elective Subject: Computer Applications SEMESTER – IV		
Year – II	Paper No: MIMMJ 244A	Credits 4= 2T +2P
Semester-IV	Name of Paper: Web Technology	Hours 30
Course specific outcomes- This course will enable the student to: CO1: To Build dynamic website. CO2: Using MVC based framework (easy to design and handling the errors in dynamic website.) CO3: To develop dynamic and interactive Web Pages.		
COURSE CONTENT/ SYLLABUS		Lectures
Unit 1:PHP Basics 1.1 Introduction to Web server and Web browser. HTTP basics. 1.2 PHP Basics: Use of PHP, Lexical structure, Language basics. 1.3 Functions: Defining and Calling a function, Default parameters & Variable parameters, Missing parameters Variable function, Anonymous function 1.4 Strings – Types of strings, encoding, escaping, comparing, manipulating, and regular expressions. 1.5 Arrays – Indexed vs associative, multidimensional arrays; sorting, searching, and extracting. 1.6 PHP Error Handling – Handling and managing errors. 1.7 Super Global Variables – EGPCS (Environment, GET, POST, Cookie, Server).		10
Unit 2: Files and database handling 2.1 Working with Files and Directories: Opening, closing, and managing files. 2.2 File Operations: Getting file information, reading/writing, splitting names and paths. 2.3 Ownership and Permissions: Setting and checking file permissions. 2.4 Database Basics: Connecting to relational databases using PHP, PEAR DB basics. 2.5 Advanced Database Techniques: Complex queries and database optimization. 2.6 Handling Forms: Sticky and self-processing forms.		8

<p>Unit 3: Introduction to Web Techniques</p> <p>3.1 Sessions and Cookies – Creating and managing sessions and cookies.</p> <p>3.2 PHP and XML – Structure of XML, using PHP for parsing and handling XML.</p> <p>3.3 XML Techniques – DOM, simple XML extension, modifying XML values.</p> <p>3.4 JavaScript Basics – Data types, variables, functions, and events.</p> <p>3.5 JavaScript Objects – Arrays, objects, JSON, and HTML DOM.</p> <p>3.6 Promises and Callbacks – Handling asynchronous operations in JavaScript.</p> <p>3.7 Regular Expressions – Pattern matching in PHP and JavaScript.</p>	7
<p>Unit 4: AJAX</p> <p>4.1 Introduction to AJAX – Basics of AJAX and how it works with PHP.</p> <p>4.2 AJAX Validation – Performing form validation using AJAX.</p> <p>4.3 Handling Data with AJAX – Managing JSON data using PHP and AJAX.</p> <p>4.4 Introduction to CodeIgniter – Overview, installation, and MVC structure.</p> <p>4.5 Building a Simple App with CodeIgniter – Create a basic CRUD app.</p>	5
<p>Practical Based on Web technology</p> <p>Practical 1: Basics of HTML</p> <p>Practical 2: Functions & Strings</p> <p>Practical 3: Arrays</p> <p>Practical 4: Files And Directories</p> <p>Practical 5: XML</p> <p>Practical 6: Database Handling</p> <p>Practical 7: Session and Cookies</p> <p>Practical 8: JavaScript</p>	Hours 60
References	<ol style="list-style-type: none"> 1. Programming PHP By Rasmus Lerdorf and Kevin Tatroe, O'Reilly publication 2. Beginning PHP 5, Wrox publication 3. PHP web services, Wrox publication 4. AJAX Black Book Kogent solution. 5. Professional Codeigniter by Thomas Myer, Wrox Publication
Learning Outcomes	<p>LO1: Create a dynamic website.</p> <p>LO2: Using MVC based framework, also can design and handle the errors in dynamic website.</p> <p>LO3: Can develop dynamic and interactive Web Pages.</p>

	MODERN EDUCATION SOCIETY'S NOWROSJEE WADIA COLLEGE, PUNE	Academic Year 2025-2026
	Masters of Science with Major in Industrial Mathematics with Computer Applications	
Year II	Paper No: MIMMJ 244-B	Credits 2
Semester IV	Name of Paper- Digital Image Processing and Applications	Hours 30
Course specific outcomes- This course will enable the student to:		
CO1: To make students understand image fundamentals and how digital images can be processed. CO2: To know Image enhancement techniques and its application. CO3: To know Image compression and its applicability for real-time image processing.		
COURSE CONTENT / SYLLABUS		Lectures
Unit 1- Introduction 1.1 Components of an Image Processing system and Applications 1.2 Human Eye and Image Formation Sampling and Quantization. 1.3 Image processing operations: Image Enhancement: Spatial Domain- Gray Level transformations, Histogram, Arithmetic/Logical Operations, Spatial filtering, Smoothing and Sharpening Spatial Filters, Frequency domain filtering and smoothening operation.		10
Unit 2- Image segmentation and Thresholding 1.1 Introduction to morphological operations 1.2 binary morphology- erosion, dilation, opening and closing operations, applications 1.3 basic gray-scale morphology operations. 2.4 Image Restoration and compression- Inverse filtering, Wiener Filtering 2.5 Image Compression Standards JPEG, JPEG 2000, MPEG; Video compression.		10
Unit 3- Color image processing 3.1 Color fundamentals, color models, Pseudo- color image processing 3.2 Basics of full color image processing, color transformation 3.3 Color image filtering: smoothening and sharpening 3.4 Color segmentation: segmentation in HSI color space 3.5 Segmentation in RGB color space, color edge detection.		12
References:	1. Digital Image Processing, R. C. Gonzalez and R. E. Woods, Pearson Education. 2. Digital Image Processing using MATLAB, R. C. Gonzalez, R. E. Woods and S. L. Eddins, Pearson Education. 3. Fundamentals of Digital Image processing, A. K. Jain, Pearson Education. 4. Digital Image Processing, Kenneth & Castleman (PHI). 5. Digital Image Processing & Analysis, Chanda & Mazumdar (PHI).	
Learning Outcomes:	LO1: Understanding of image fundamentals and how digital images can be processed. LO2: Knowledge of various Image enhancement techniques and its application. LO3: Knowledge of Image compression and its applicability for real-time image processing.	

The Examination pattern for all postgraduate (PG) courses.

EVALUATION PATTERN: For Two Credit Courses

- (i) Each course shall be evaluated with Continuous Evaluation (CE) and End Semester Examination (EE).
- (ii) Continuous Evaluation shall be of 15 marks and End Semester Examination (EE) shall be of 35 marks
- (iii) To pass a course of 2credits, a student has to earn minimum 20 marks, provided that he/she should earn minimum 6 marks in Continuous Evaluation and minimum 14 marks in End-Semester Examination. That is passing criterion is minimum 40% marks in the examination.
- (iv) For Internal evaluation (out of 15 marks), There has to be one written test of 10 marks (Mid-Semester Examination). For remaining 5 marks shall be based on the continuous evaluation consisting of tutorial, viva, seminars, home-assignments, mini project, survey, group discussion etc.(on approval of Head of the Department)
- (v) There shall be reevaluation of the answer scripts of End-Semester Examination (out of 35 marks) of theory papers only, but not of internal assessment papers as per Ordinance No. **134 A and B**.

ATKT RULES

- (i) Minimum number of credits required to take admission to Second year of B. Sc. course is 31 (70%) (As same as SPPU).
- (ii) Minimum number of credits required to take admission to Third year of B. Sc. course is 44 (100%) to be completed from First year of B. Sc. and pass in physical education examination in first year of B. Sc. and 22 credits from second year of B. Sc (As same as SPPU).

AWARD OF GRADES AND GRADE POINTS

The mapping of percentage to letter grade and grade point is given in the following Table 1

CGPA will be calculated as follows:

Table No. 1

Sr. No.	Grade Letter	Grade Point	Marks
1.	O (Outstanding)	10	$90 \leq \text{Marks} \leq 100$
2.	A+ (Excellent)	9	$80 \leq \text{Marks} \leq 89$
3.	A (Very Good)	8	$70 \leq \text{Marks} \leq 79$
4.	B+ (Good)	7	$55 \leq \text{Marks} \leq 69$
5.	B (Above Average)	6	$50 \leq \text{Marks} \leq 54$
6.	C (Average)	5	$45 \leq \text{Marks} \leq 49$
7.	D (Pass)	4	$40 \leq \text{Marks} \leq 44$
8.	F (Fail)	0	Marks < 40
9.	Ab (Absent)	0	

PERFORMANCE INDICES:

The performance of a student in a Semester is indicated by a number called the Semester Grade Point Average (SGPA). Similarly, the performance of a student in the Course is indicated by a number called the Course Grade Point Average (CGPA).

The End-Semester results and final result of the courses will contain SGPA and CGPA, respectively.

- (1) **SGPA**: The SGPA is the weighted average of the grade points obtained by a student in all the courses during the Semester. That is

$$SGPA = \frac{\sum_{i=1}^p C_i G_i}{\sum_{i=1}^p C_i}$$

For example, suppose in a Semester, student has registered for five courses having credits C_1, C_2, C_3, C_4 and C_5 and suppose his/her grade points are G_1, G_2, G_3, G_4 and G_5 , respectively. The SGPA is calculated as

$$SGPA = \frac{C_1 G_1 + C_2 G_2 + C_3 G_3 + C_4 G_4 + C_5 G_5}{C_1 + C_2 + C_3 + C_4 + C_5}$$

SGPA is calculated correct up to two decimal places by rounding off.

- (2) **CGPA**: The CGPA is the weighted average of the grade points obtained in all courses (theory and Practical) by students in all the courses in 6 semesters. It is calculated in the same manner as the SGPA.

RESULTS:

Based on the performance of the student in the Semester Examinations, Nowrosjee Wadia College will declare the results and issue the Semester Grade sheets. Also, the College will declare the results and issue the Grade sheets at the end of the course.

The class will be awarded to a student on the basis of CGPA. The award of the class shall be as per Table 2 and corresponding percentage calculation for the CGPA is given in Table No. 3

Table 2

Sr. No.	CGPA	Class of the degree awarded
1	9.50 or more than 9.50	OUTSTANDING (O)
2	8.50 or more but less than 9.50	EXCELLENT (A+)
3	7.50 or more but less than 8.50	VERY GOOD (A)
4	6.25 or more but less than 7.50	GOOD (B+)
5	5.25 or more but less than 6.25	ABOVE AVERAGE (B)
6	4.75 or more but less than 5.25	AVERAGE (C)
7	4.00 or more but less than 4.75	PASS (D)

Percentage of marks corresponding to CGPA is calculated by the formulae which are given in the following Table 3.

Table 3

GRADE	Formula for the percentage of marks
O	$20 \times \text{CGPA} - 100$
A+	$10 \times \text{CGPA} - 5$
A	$10 \times \text{CGPA} - 5$
B+	$12 \times \text{CGPA} - 20$
B	$5 \times \text{CGPA} + 23.75$
C	$10 \times \text{CGPA} - 2.50$
D	$6.6 \times \text{CGPA} + 13.6$

The above percentage calculations are illustrated in the following Table 4

Table 4

Some examples of CGPA to Percentage calculations

CGPA obtained	Formula	Percentage (%)	Grade
10	$20 \times 10 - 100 = 100$	100	O
9.75	$20 \times 9.75 - 100 = 95$	95	O
9.5	$20 \times 9.5 - 100 = 90$	90	O
9.0	$10 \times 9 - 5 = 85$	85	A+
8.0	$10 \times 8.0 - 5 = 75$	75	A
7.0	$12 \times 7.0 - 20 = 64$	64	B+
6.67	$12 \times 6.67 - 20 = 60.04$	60.04	B+
6.25	$12 \times 6.25 - 20 = 55$	55	B+
5.25	$5 \times 5.25 + 23.75 = 50$	50	B
4.75	$10 \times 4.75 - 2.50 = 45$	45	C
4.0	$6.6 \times 4.0 + 13.6 = 40$	40	D

While declaring the results, the existing ordinances are applicable. There is also a provision for verification and revaluation. In case of verification, the existing rules will be applicable. The revaluation result will be adopted if there is a change of at least 10% marks and in the grade of the course.

PATTERN OF THE QUESTION PAPER: Two Credits

(1) Internal Examination:

(Mid-Semester Examination of 10 marks, Duration: 30 Mins)

Question No.	Total Marks	No. Of questions	Remarks
Q. 1.	5	Attempt any 5 out of 7	Definitions/Counter examples/Short answer / objective type of questions/True or False. (Each question carries 1 mark.)
Q. 2.	5	Solve any 1 out of 2 questions	Descriptive type questions (Each question carries 5 marks)

(2) End Semester Examination (EE):

Shall be of 35 marks, 2 hours duration. The pattern of the question paper shall be as follows:

Question No.	Total Marks	No. Of questions	Remarks
Q. 1.	5	Solve any 5 out of 7	Definitions/Counter examples/Short answer / objective type of questions/True or False. (Each question carries 1 mark.)
Q. 2.	10	Solve any 5 out of 7 OR Solve any 2 out of 3	Descriptive type questions (Each question carries 5 marks)
Q. 3.	10	Solve any 2 out of 3	Descriptive type questions (Each question carries 5 marks)
Q. 4.	10	Solve any 2 out of 3 OR Solve any 1 out of 2	Descriptive type questions

EVALUATION PATTERN: For Four Credit Courses

- (i) Each course shall be evaluated with Continuous Evaluation (CE) and End Semester Examination (EE).
- (ii) Continuous Evaluation shall be of 30 marks and End Semester Examination (EE) shall be of 70 marks
- (iii) To pass a course of 4credits, a student has to earn minimum 40 marks, provided that he/she should earn minimum 12 marks in Continuous Evaluation and minimum 28 marks in End-Semester Examination. That is passing criterion is minimum 40% marks in the examination.
- (iv) For Internal evaluation (out of 30 marks), There has to be one written test of 20 marks (Mid-Semester Examination). For remaining 10 marks shall be based on the continuous evaluation consisting of tutorial, viva, seminars, home-assignments, mini project, survey, group discussion etc. (on approval of Head of the Department)
- (v) There shall be reevaluation of the answer scripts of End-Semester Examination (out of 70 marks) of theory papers only, but not of internal assessment papers as per Ordinance No. **134 A and B.**

PATTERN OF THE QUESTION PAPER: Four Credits**(1) Internal Examination:**

(Mid-Semester Examination of 20 marks, Duration: 60 Mins)

Question No.	Total Marks	No. Of questions	Remarks
Q. 1.	10	Attempt any 5 out of 7	Definitions/Counter examples/Short answer / objective type of questions/True or False. (Each question carries 2 marks)
Q. 2.	10	Solve any 1 out of 2 questions	Descriptive type questions (Each question carries 10 marks)

(2) End Semester Examination (EE):

Shall be of 70 marks, 3 hours duration. The pattern of the question paper shall be as follows:

Question No.	Total Marks	No. Of Questions	Remarks
Q. 1.	10	Solve any 5 out of 7	Definitions/ Counter examples/ Short answer / Objective type of questions/ True or False. (Each question carries 2 marks)
Q. 2.	20	Solve any 5 out of 7 OR Solve any 2 out of 3	Descriptive type questions
Q. 3.	20	Solve any 2 out of 3	Descriptive type questions (Each question carries 5 marks)
Q. 4.	20	Solve any 2 out of 3 OR Solve any 1 out of 2	Descriptive type questions