Department of Mathematics

Discipline Specific Core Course: Mathematics

Sem	Theory/ Practical	Course Title	Teaching/ Practical Instruction hour/week	Total Hour/ Sem	Duration of Exam in hours	Assessment Marks			Credits
						Summative	Formative	Total	
V	Theory	Numerical Analysis-I and Complex Analysis-I	4	60	3	80	20	100	4
	Practical	Mathematics Lab-V(A)	4	60	3	40	10	50	2
	OR								
	Theory	Graph Theory-I and Linear Algebra-I	4	60	3	80	20	100	4
	Practical	Mathematics Lab-V(B)	4	60	3	40	10	50	2
	Elective	Mathematics for All-I	4	60	3	80	20	100	3

24MT-5a-NUMERICAL ANALYSIS-I AND COMPLEX ANALYSIS-I	
Total Contact Hours: 4 hours/week (L:T:P- 4:0:0)	**Credits: 4**
Total Teaching Hours : 60 Hours **Duration of Examination : 3 Hours**	**Max. Marks: 100** **(Internal Assessment Marks: 20** **Semester End Exam Marks: 80)**

Course Learning Objectives:

- Understand Error Theory and Solve Non-Linear Equations by iterative techniques such as the Bisection, Regula-Falsi, and Newton-Raphson methods to find roots of transcendental and algebraic equations.
- Implement direct and iterative methods (e.g., Gaussian Elimination, Jacobi, and Gauss-Seidel) to solve large systems of linear equations.
- Analyze Complex Functions and Utilize the Cauchy-Riemann equations to determine the analyticity of a function and construct harmonic conjugates.

Course Outcome(COs):

On successful completion of the course, the student will able to:

- Analyze the sources of numerical errors and apply error propagation techniques to determine the precision of computed results.
- Solve algebraic and transcendental equations using iterative methods and evaluate their rates of convergence.
- Demonstrate a conceptual understanding of the geometry and topology of the complex plane and basic complex functions.
- Examine functions for analyticity using the Cauchy-Riemann equations and identify harmonic functions in physical applications.

Units	Description	Hours
UNIT-I	**Errors and Solutions of non-linear equations:** Classification of errors (absolute, rounding, relative and percentage errors), general error formula (derivation of formula and problems based on it), error in series approximation: Truncation error in Taylor series approximations (problems only). Relation connecting the errors with illustrations. Solutions of nonlinear equations, method of successive bisection, method of false position, Newton Raphson's iterative method, the secant method (Plain discussion of the rationale behind techniques and problems on their applications).	15
UNIT-II	**Solutions of system of equations and Finite differences:** Gauss elimination method, Gauss Jordan elimination method, Jacobi method, Gauss-Seidel method.	15

	Finite differences definition and properties of Δ, ∇, E and relations between them, the n^{th} difference of a polynomial, difference table (forward and backward), method of separation of symbols, Factorial notation.	
UNIT-III	**Complex Numbers and Analytic Functions:** Introduction, complex number, Conjugation and modulus, inequalities, square root, Geometrical representation of complex number, n^{th} root of complex numbers, circles and straight lines, regions in the complex plane, the extended complex plane. Analytic Functions, introduction, functions of complex variable, limits, theorem on limits, continuous functions, differentiability, the Cauchy Riemann equations, Analytic functions, harmonic functions.	15
UNIT-IV	**Bilinear Transformation:** Introduction, Elementary Transformations, extended complex plane and Bilinear Transformations, Cross ratio fixed point of Bilinear Transformations, Some special Bilinear Transformation.	15

References/Text books:

1. Dr. B.S. Grewal – Higher Engineering Mathematics.
2. Burden, R. L., &Faires, J. D. – Numerical Analysis
3. Chapra, S. C., &Canale, R. P. – Numerical Methods for Engineers
4. G K Ranganath, Text Book of B.Sc. Mathematics, S Chand & Company.
5. Sastry, S. S. – Introductory Methods of Numerical Analysis
6. Atkinson, K. E. – An Introduction to Numerical Analysis
7. Gerald, C. F., & Wheatley, P. O. – Applied Numerical Analysis
8. Churchill, R. V., & Brown, J. W. – Complex Variables and Applications
9. Ponnusamy, S. – Foundations of Complex Analysis
10. Needham, T. – Visual Complex Analysis

PRACTICAL PAPER 24MP-5a- MATHEMATICS LAB-V(A)	
Total Contact Hours: 4 hours/week (L:T:P- 0:0:4)	**Credits: 2**
Total Teaching Hours : 60 Hours **Duration of Examination : 3 Hours**	**Max. Marks: 50** **(Internal Assessment Marks: 10** **Semester End Exam Marks: 40)**

Course Learning Objectives:

- Develops foundational skills in programming concepts and methodologies.
- Enhances understanding of mathematical concepts through interactive software-based experiments.
- Strengthens programming fundamentals and logical thinking.
- Develops understanding of how algebra and calculus are used in practical scenarios through hands-on experiences with FOSS.

Course Outcome:

On successful completion of the course, the student will able to:

- Acquire knowledge of FOSS tools and their applications in computer programming.
- Develop and improve coding skills using Programming Language.
- Develop skills in applying software tools to mathematical concepts.
- Build a strong foundation in programming principles and practices.
- Understand the impact of mathematics on science, technology, engineering, and mathematics (STEM) fields.
- Build a strong foundation for future learning and exploration across multiple disciplines.

Syllabus: Problems from 24MT-5a (Theory) may be solved with the help of programming.

Suggested Software's: Maxima/Scilab/Phython.

List of Programs (Suggested):

Recapitulation of Maxima/SciLab/ **Phython** Commands related to the Topic

1. Finding the real root of a nonlinear equations by bisection method.
2. Finding the real root of a nonlinear equations by method of false position.
3. Finding the real root of a nonlinear equations by Newton Raphson's method.
4. Finding the real root of a nonlinear equations by secant method.

5. Solution of system of equations by Gauss elimination method.
6. Solution of system of equations by Gauss Jordan elimination method.
7. Solution of system of equations by Jacobi's method.
8. Solution of system of equations by Gauss Seidel method.
9. Construction of Difference table (Forward and Backward).
10. Construction of analytic function when the real part of f(z) is given.
11. Construction of analytic function when the imaginary part of f(z) is given.
12. Verify the given real or imaginary part of an analytic function to harmonic.

NOTE: Use the MAXIMA/SciLab/Python Software to execute the practical problems and verify manually

24MT-5b-GRAPH THEORY-I AND LINEAR ALGEBRA-I	
Total Contact Hours: 4 hours/week (L:T:P- 4:0:0)	**Credits: 4**
Total Teaching Hours : 60 Hours **Duration of Examination : 3 Hours**	**Max. Marks: 100** **(Internal Assessment Marks: 20** **Semester End Exam Marks: 80)**

Course Learning Objectives:

- Understand fundamental concepts of Graph theory.
- Calculate degrees and apply the Handshaking Lemma (odd-degree vertices are even).
- Distinguish between walks, trails, and paths; solve shortest path problems.
- Characterize bipartite graphs using their lack of odd cycles.
- Apply Eulerian and Hamiltonian properties to solve TSP and Chinese Postman problems.
- Verify vector space and subspace definitions using standard axioms.
- Determine Linear Independence, Span, and the minimal set of basis vectors.
- Apply the Rank-Nullity Theorem to find the dimensions of mapping spaces.

Course Outcome(COs):

On successful completion of the course, the student will able to:

- Identify and differentiate between finite, null, complete, and bipartite graphs.
- Apply the Handshaking Lemma and analyze vertex degrees.
- Distinguish between spanning, induced, and total graphs.
- Solve shortest path problems and characterize bipartite graphs via cycles.
- Traversal Problems: Master Eulerian and Hamiltoniancircuits.
- Solve Traveling Salesman and Chinese Postman problems.
- Verify vector space and subspace definitions and properties.
- Determine Linear Independence, Span, and calculate Dimension.
- Identify and apply properties of linear transformations.
- Solve problems using the Rank-Nullity Theorem.

Units	Description	Hours
UNIT-I	**GRAPHS:** Introduction, finite and null graphs, connectedness and components, degree of vertex, minimum and maximum degree, $\sum \deg v_i = 2q$, the number of vertices of odd degree is even, Isomorphism, complete graph, line graph, total graph, sub graphs, spanning and induced sub graphs, walk, trial, path, cycle, the shortest path problems, bipartite graphs, characterization of bipartite graph in terms of its cycle.	15
UNIT-II	**EULERIAN AND HAMILTONIAN GRAPHS:** Introduction the Kenigsberg bridge(new name as Kalingrad) problem, travelling salesman problem, chinese postman	15

	problem, characterization of Eulerian graphs, Properties of Hamiltonian graphs, some applications graphs in electronic network, cut vertex, bridge, block,tree, spanning tree, rooted and binary trees, forest, some properties of trees.	
UNIT-III	**VECTOR SPACE:** Introduction, Vector Space definition and axioms, vector subspaces and its properties, Linear combination, Linear Independence and Span, Bases and Dimension, quotient spaces and its properties, sum and direct sum of subspaces in vector space.	15
UNIT-IV	**LINEAR TRANSFORMATIONS:** Introduction, Properties of Linear transformation, Change of basis and effect on associated matrix, similar matrices and Matrix Representation of linear transformation, Null space (Kernel) and Range space, proof of Rank Nullity theorem and related problems,.	15

References/Text books:

1. Richard J. Trudeau- Introduction to graph theory.
2. Reinhard Diestel- Graph Theory.
3. K. Patrai – Graph Theory.
4. Graph Theory: Frank Hararry, Narosa Publications
5. Graph Theory and Its Applications :D.S.Chandrashekharaiah.
6. Graph Theory and Its Applications :Vasudev.
7. Graph Theory: V. R. Kulli, Vishwa International Publications.
8. I. N. Herstein, Topics in Algebra, 2nd Edition, Wiley.
9. Stephen H. Friedberg, Arnold J. Insel& Lawrence E. Spence (2003), Linear Algebra (4th Edition), Prentice-Hall of India Pvt. Ltd.
10. F. M. Stewart, Introduction to Linear Algebra, Dover Publications.
11. S. Kumaresan, Linear Algebra, Prentice Hall India Learning Private Limited.
12. Kenneth Hoffman & Ray Kunze (2015), Linear Algebra, (2nd Edition), Prentice Hall India Learning Private Limited.
13. Gilbert. Strang (2015), Linear Algebra and its applications, (2nd Edition), Elsevier.
14. VivekSahai& VikasBist (2013), Linear Algebra (2nd Edition) Narosa Publishing.

PRACTICAL PAPER 24MP-5b- MATHEMATICS LAB-V(B)	
Total Contact Hours: 4 hours/week (L:T:P- 0:0:4)	**Credits: 2**
Total Teaching Hours : 60 Hours **Duration of Examination : 3 Hours**	**Max. Marks: 50** **(Internal Assessment Marks: 10** **Semester End Exam Marks: 40)**

Course Learning Objectives:

- Develops foundational skills in programming concepts and methodologies.
- Enhances understanding of mathematical concepts through interactive software-based experiments.
- Strengthens programming fundamentals and logical thinking.
- Develops understanding of how algebra and calculus are used in practical scenarios through hands-on experiences with FOSS.

Course Outcome:

On successful completion of the course, the student will able to:

- Acquire knowledge of FOSS tools and their applications in computer programming.
- Develop and improve coding skills using Programming Language.
- Develop skills in applying software tools to mathematical concepts.
- Build a strong foundation in programming principles and practices.
- Understand the impact of mathematics on science, technology, engineering, and mathematics (STEM) fields.
- Build a strong foundation for future learning and exploration across multiple disciplines.

Syllabus: Problems from 24MT-5a (Theory) may be solved with the help of programming.

Suggested Software's: Maxima/ Scilab / Phython.

List of Programs (Suggested):

Recapitulation of Maxima/SciLab/ **Phython** Commands related to the Topic

1. Drawing of Simple, Pseudo and multiple graphs
2. Drawing of regular connected complete, complementary graphs.
3. Drawing of sub-graphs, Induced sub-graphs and spanning sub-graphs.
4. Drawing of bipartite, complete bipartite graphs.

5. Drawing of Walk, Trail, Path and Cycle.
6. Program on linear combination of vectors.
7. Program to verify linear dependence and independence.
8. Program to find basis and dimension of the subspaces.
9. Program to verify if a function is linear transformation or not.
10. Program to find the matrix of linear transformation.
11. Program to find the Eigenvalues and Eigenvectors of a given linear transformation.
12. Program on Rank – nullity theorem.

NOTE: Use the MAXIMA/SciLab/Python Software to execute the practical problems and verify manually

24MTOE-1-MATHEMATICS FOR ALL-I	
Total Contact Hours: 3 hours/week (L:T:P- 3:0:0)	**Credits: 3**
Total Teaching Hours : 48 Hours **Duration of Examination : 3 Hours**	**Max. Marks: 100** **(Internal Assessment Marks: 20** **Semester End Exam Marks:80)**

Course Learning Objectives:

- Apply concepts of percentage, profit & loss, discount, commission, and ratio-proportion to solve problems in trade, business, and day-to-day transactions.
- Perform operations on algebraic expressions, factorization, and solve linear and quadratic equations in one variable.
- Explain the concepts of limits, continuity, and differentiability of functions of one variable and apply them to test given functions
- Solve optimization problems from geometry, business, and economics by formulating them as functions and applying maxima-minima techniques.

Course Outcome(COs):

On successful completion of the course, the student will able to:

- Develop computational skills in commercial contexts
- Understand financial mathematics
- Master algebraic fundamentals
- Apply set theory and logic
- Strengthen problem-solving ability
- Build foundation for higher studies
- Use modern tools: Develop familiarity with calculators/spreadsheets for performing commercial arithmetic computations accurately and efficiently.

Units	Description	Hours
UNIT-I	**Commercial Arithmetic and Algebraic Foundation:** Fractions, decimals, HCF, and LCM, Ratios and proportions, percentages, profit and loss, and simple/compound interest, Solving linear and quadratic equations and their application in word problems.	12
UNIT-II	**Differential Calculus and Optimization:** Limits and Continuity, Differentiation definition, Basic derivatives. Applications of derivatives: Rolle's Theorem and Finding maximum and minimum values (Optimization) in business or science contexts.	12

UNIT-III	**Permutation & Combination**: Definition and properties of n!, Fundamental principles of counting (Rule of Sum and Product) , Introduction of permutation and combination, Permutations of like & unlike things, circular permutation and Problems related to ${}^{n}c_{r}$	12
UNIT-IV	**Statistics & Probability:** Introduction, Measures of central tendency(Mean, Mode and Median), Basic definition of probability, Events and types of event, Algebra of events and Axiomatic approach to probability.	12

References/Text books:

1. A Textbook of Business Mathematics – Padmalochan Hazarika | S. Chand
2. Business Mathematics – J.K. Singh | Himalaya Publishing House
3. Textbook of Calculus – H.K. Dass | S. Chand
4. Quantitative Aptitude – S. Chand | Arihantha publication.
5. Differential Calculus – Gorakh Prasad | Pothishala Pvt. Ltd