ST. PHILOMENA'S COLLEGE (AUTONOMOUS)

Affiliated to University of Mysore
Accredited by NAAC with 'B^{++}' Grade
Bannimantap, Mysore, Karnataka,
India-570015

DEPARTMENT OF MATHEMATICS

The Board of Studies in Mathematics which met on 22.08.2024 has approved the syllabus and pattern of examination for Semesters V and VI for the Academic Year 2024-25 onwards

BOS COMMITTEE MEMBERS

Sl. No.	Name	Designation
1	Mrs. Shruthi Menezes	Chairperson
2	Prof. Veena Mathad	Member

3	Dr. M Manjunatha	Member
4	Prof. Ruby Salestina M	Member
5	Dr. Navis Vigilia	Member
6	Ms. Ameena Firdose	Alumni

Semester V

Core Course Content

Course Title: Real Analysis II and Complex Analysis	**Course Credits**: 04
Course Code: MATDSC501	**L-T-P per week**: 4:0:0
Total Contact Hours: 64 Hours	
Formative Assessment Marks: 40	**Summative Assessment Marks**: 60

Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar/Field studies

Formative Assessment		
Assessment	**Assessment type**	**Weightage in Marks**
C1 First component	Test	10
C1 Second Component	Assignment	10
C2 First Component	Seminar	10
C2 Second Component	E content	10

Course Objectives:

1. **Understand Riemann Integration and its Applications:**
   Students will develop a thorough understanding of the Riemann integration process, including the concepts of partitions, Riemann sums, and Darboux sums. They will learn to compute integrals using these sums, explore the conditions for the integrability of functions, and apply the Fundamental Theorem of Calculus. Students will also gain proficiency in applying the change of variables, integration by parts, and using the mean value theorems of integral calculus.
2. **Master the Theory of Complex Numbers and Functions:**
   Students will explore the algebraic and geometric properties of complex numbers, including operations such as addition, multiplication, and the computation of conjugates, moduli, and arguments. They will study the Cartesian and polar forms of complex numbers, the geometric representation on the complex plane, and Euler's formula. Additionally, students will learn about analytic functions, Cauchy-Riemann equations, harmonic functions, and methods for constructing analytic functions using the Milne-Thomson method.
3. **Develop Skills in Complex Integration and Contour Integration:**
   Students will gain a solid understanding of complex integration, including the definition of line integrals, contour integrals, and their properties. They will explore Cauchy's Integral Theorem and Cauchy's Integral Formula, and learn how to apply these results to evaluate complex integrals. The course will also cover important results such as Cauchy's inequality and Liouville's theorem, with a focus on their proofs and applications.
4. **Explore Transformations and Conformal Mappings:**
   Students will study various types of transformations, including identity, reflection, translation, rotation, and magnification. They will learn about the Jacobian of a transformation and the concept of inverse points and cross-ratio preserving properties. The course will also cover conformal mappings, discussing specific transformations such as $w= z^2$, w=sin z, w = cos z, and $w = e^z$, and their applications in the context of complex analysis.

Course Outcomes: Upon completion of the course the students will learn to

1. students will be able to define and compute Riemann integrals using partitions and Riemann sums. They will demonstrate the ability to apply Darboux's theorem, verify the integrability of functions, and solve problems involving the Fundamental Theorem of Calculus, integration by parts, and the change of variables. Students will be able to handle a variety of integrable functions, including continuous, monotonic, and piecewise functions with discontinuities.
2. Students will be able to perform algebraic operations on complex numbers and convert between Cartesian and polar forms. They will be able to represent complex numbers geometrically on the

complex plane and apply Euler's formula in various contexts. Students will also gain the ability to solve problems involving analytic functions, Cauchy-Riemann equations, and harmonic functions, and will be able to construct analytic functions using methods like the Milne-Thomson technique.

3. students will be able to evaluate complex integrals using line integrals and contour integrals. They will understand and apply Cauchy’s Integral Theorem and Cauchy’s Integral Formula to compute integrals around closed contours. Students will also be able to prove and apply important results such as Cauchy’s inequality and Liouville’s theorem to solve problems in complex analysis.
4. Students will be able to analyze and apply various transformations, including reflection, translation, rotation, and magnification, and compute the Jacobian for these transformations. They will understand the concept of cross-ratio preservation and be able to identify and apply conformal mappings to functions such as $w = z^2$, w = sin z, and $w = e^z$. Additionally, students will demonstrate the ability to solve problems involving inverse points and mappings of straight lines and circles.

Course Content:

UNIT 1	**Riemann Integration-I**	**15 Hours**
1.1	Definition & examples for partition of an interval, Refinement and Common refinement of a partition	
1.2	Lower and upper Riemann (Darboux) sums – definition, properties & problems.	
1.3	Riemann Integral- Lower and Upper integrals (definition & problems), Darboux’s theorem	
1.4	Criterion for Integrability of sum, difference, product, quotient and modulus of integrable functions	
1.5	**Integral as a limit of sum (Riemann sum)- Problems. Some integrable functions** - Integrability of continuous functions, monotonic functions, bounded function with finite number of discontinuities	
1.6	Fundamental theorem of Calculus-related problems, change of variables, integration by parts, first and second mean value theorems of integral calculus.	
UNIT 2	**Complex number**	
2.1	Conjugate of complex number and their properties, Modulus of complex number and their properties, A.rgument of complex number.	**15 Hours**
2.2	Cartesian and Polar form (Definitions, properties and problems).	
2.3	Geometrical representation of complex plane (z-plane); Euler’s formula, e^{ix}=**cosx+isin**x.	
2.4	Separate the real and imaginary parts of some standard functions (e^z, sin z , cos z, log z etc).	
2.5	Dot and vector product of z1 and z2. Equation of a straight line and circle in a complex form and represent graphically (locus of a point).	
2.6	Functions of a complex variable- Limit of a function, Continuity and differentiability, Analytic functions, Singular points (definitions and related problems)	

2.7	Cauchy-Riemann equations – Cartesian and Polar forms – Proof & Problems, Necessary and sufficient condition for a function to be analytic (Statement only)	
2.8	Harmonic functions. Definitions and problems; Properties of analytic functions – Various properties with proofs	
2.9	Construction of analytic functions; i)Milne Thomson Method (Only problems) ii) Using the concept of harmonic function.	
UNIT 3	**Complex Integration**	**15 Hours**
3.1	Complex integration- definition, Line integral, properties and problems	
3.2	Contour Integrals (definitions, properties and problems) Fundamental theorem for contour integrals.	
3.3	Cauchy's Intergral theorem- proof using Green's theorem- direct consequences	
3.4	Cauchy's Integral formula with proof – Cauchy's generalized formula for the derivatives with proof and applications for evaluation of simple line integrals	
3.5	Cauchy's inequality- Proof, Livouville's theorem- Proof.	
UNIT 4	**Transformations**	**15 Hours**
4.1	Definitions, Jacobian of a transformation	
4.2	Identity transformation- Reflection- Translation- Rotation and Magnification	
4.3	Inversion- Inverse points-Cross-ratio preserving property- Preservation of the family of straight lines and circles	
4.4	Conformal mappings- Discussion of the transformations w=z^2, w=sin z, w= cos z, w=e^z, w=$\frac{1}{z}(1+\frac{1}{z})$ etc.	

REFERENCE BOOKS:

1.	Ajit Kumar and S.Kumaresan – A Basic Course in Real Analysis, Taylor and Francis Group
2.	Bruce P. Palka. Introduction to the Theory od functions of a Complex Variable. Springer
3.	L.V.Ahlfors, Complex Analysis, 3rd edition, Mc Graw Hill Education
4.	Richard R Goldberg, Methods of Real Analysis, Oxford and IBH Publishing
5.	R.V.Churchill & J.W.Brown, Complex Variables and Applications, 5th ed, Mc Graw Hill Companies
6.	Shanthinarayan, Theory of Functions of a Complex Variable, S. Chand Publishers
7.	Serge Lang, Complex Analysis, Springer
8.	S.C.Malik and Savita Arora, Mathematical Analysis, 5th ed. New Delhi, India: New Age international(P)Ltd., 2017
9.	S.C.Malik, Principles of Real Analysis, New Age International (India) Pvt.Ltd., 4th Edition, 2018
10.	S.Ponnuswamy, Foundations of Complex Analysis, 2nd edition, Alpha science International Limited

Title	**PRACTICAL'S ON REAL ANALYSIS II AND COMPLEX ANALYSIS**	
Code	**MATDSCP501**	
Teaching Hours: 4 Hours/week		**Credits: 2**
Total Teaching hours:60 Hours		**Max. Marks: 50** **(S.A. : 25 + I.A. : 25)**

Course Learning Outcome:

This course will enable the students to	
CLO-1	Learn *Free and OpenSource Software (FOSS)* tools for computer programming.
CLO-2	Solve problem on Real analysis and complex analysis studied in **MATDSCT 501 by** using FOSS software's.
CLO-3	Acquire knowledge of applications of Real Analysis and Complex Analysis through FOSS

Practical/Lab Work to be performed in Computer Lab (FOSS)
Suggested Software's: Maxima/Scilab/Python/R.

1	Program to check whether a given set of real numbers attains supremum or infimum.
2	Program to find upper and lower Riemann sums with respect to given partition.
3	Program to test Riemann Intergrability
4	Program to evaluate Riemann integral as a limit of a sum
5	Program on verification of Cauchy- Riemann equations (Cartesian form) or test for analyticity
6	Program on verification of Cauchy- Riemann equations (Polar form) or test for analyticity.
7	Program to check whether a function is harmonic or not
8	Program to construct analytic functions (through Milne- Thompson method)
9	Program to find Cross ratio of points and related aspects
10	Program to find fixed points of bilinear transformations
11	Program to verify De-Moivre's theorem

Semester V
Core Course Content

Course Title: ADVANCED ALGEBRA AND DISCRETE MATHEMATICS	**Course Credits**: 04
Course Code: MATDSC502	**L-T-P per week**: 4:0:0

Total Contact Hours: 64 Hours	
Formative Assessment Marks: 40	**Summative Assessment Marks**: 60

Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar/Field studies

Formative Assessment		
Assessment	**Assessment type**	**Weightage in Marks**
C1 First component	Test	10
C1 Second Component	Assignment	10
C2 First Component	E Content	10
C2 Second Component	Seminar	10

Course Objectives:

1. **Develop a Deep Understanding of Ring and Field Theory:**
   Students will gain a comprehensive understanding of the fundamental concepts of rings, fields, integral domains, and subrings, with a focus on their properties and operations. They will study ideals, including prime and maximal ideals, and learn to apply the theory of divisibility, units, and associates in integral domains to solve related problems.
2. **Explore Polynomial Rings, Homomorphisms, and Isomorphisms:**
   Students will learn the theory of quotient rings, homomorphisms, and isomorphisms, and develop skills to compute kernels and apply the Fundamental Theorem of Homomorphism. They will also study polynomial rings, division algorithms, the Euclidean algorithm, and techniques for determining the reducibility and irreducibility of polynomials over fields, including the use of Eisenstein's criterion.
3. **Master Vector Algebra and Vector Calculus:**
   Students will acquire proficiency in the core concepts of vector algebra, including vector and scalar fields, dot and cross products. They will study vector differentiation, focusing on gradient, divergence, and curl, and apply these operators to solve problems in vector calculus. Additionally, students will understand and apply important vector integration theorems such as Green's Theorem and Stokes' Theorem.
4. **Introduce Fundamental Concepts of Graph Theory:**
   Students will gain a solid foundation in basic graph theory, including the study of isomorphism, subgraphs, walks, paths, and circuits. They will explore the properties of connected and disconnected graphs, as well as Eulerian and Hamiltonian graphs, and study the concepts of trees, spanning trees, and minimal spanning trees, with an emphasis on their applications and problem-solving techniques.

Course Outcomes: Upon completion of the course the students will learn to

1. students will be able to define and apply the concepts of rings, integral domains, and fields. They will demonstrate a clear understanding of subrings, ideals, and the properties of prime and maximal

ideals in commutative rings. Students will be able to solve problems involving divisibility in integral domains, and apply theorems related to units and associates within these structures.

2. Students will acquire the skills to work with quotient rings, understand the construction of the field of quotients, and apply related theorems to solve problems. They will develop an understanding of ring homomorphisms, kernels, and isomorphisms, and be able to prove and apply the Fundamental Theorem of Homomorphism of Rings. Additionally, students will study polynomials over rings and fields, including concepts such as reducibility, irreducibility, and the application of Eisenstein's criterion for polynomial factorization.
3. Students will understand the concepts of vectors, scalars, vector fields, and scalar fields, and will be able to compute dot and cross products. They will gain proficiency in vector differentiation, including the use of gradient, divergence, and curl operators, and will solve problems involving these vector differential operators. Students will also master vector integration, applying Green's Theorem and Stokes' Theorem to solve problems in vector calculus.
4. students will be able to define and work with basic graph theory concepts, including isomorphism, subgraphs, walks, paths, and circuits. They will study connected and disconnected graphs and explore specific types of graphs such as Euler and Hamiltonian graphs. Additionally, students will learn the key properties of trees, including distance, eccentricity, and spanning trees, and will be able to apply algorithms for finding minimal spanning trees in various graph-related problems.

Course Content:

UNIT 1	**Rings and Fields**	**15 Hours**
1.1	Rings – definition and properties of rings	
1.2	Integral domain and Fields – theorems and problems	
1.3	Sub rings – Criterion for sub rings – theorems and problems on sub rings	
1.4	Ideals – Algebra of ideals theorems – Principal ideals – examples	
	and standard properties following the definition.	
1.5	Prime and Maximal ideal in a commutative ring – definition and examples	
1.6	Divisibility in an integral domain – theorems and problems, Units and Associates – theorems and problems	
UNIT 2	**Polynomial rings and Homomorphism**	**15 Hours**
2.1	Quotient rings- examples and theorems – The field of quotients – theorems and problems	
2.2	Homomorphism- Definitions and examples	
2.3	Kernel of a homomorphism- examples and related theorems	
2.4	Isomorphism of a ring- examples and related theorems	
2.5	Automorphism- problems, Fundamental Theorem of Homomorphism of Rings	
2.6	Polynomials over rings and fields, division algorithm (problems), Greatest common divisor – Euclidian algorithm (problems)	
2.7	Reducible and irreducible polynomials over fields (definitions and problems); Eisenstein's criteria for reducibility – problems	
2.8	Rational roots of a polynomial – Test – problems	
UNIT 3	**Vector Algebra**	**15 Hours**
3.1	Vectors, Scalars, Vector Field, Scalar field (definition and problems)	
3.2	Dot and cross product	
3.3	Vector differentiation – The vector differential operator: Gradient, Divergence, Curl -– Standard derivations and problems	

3.4	Vector integration: Green's theorem in plane (definition and problems).	
3.5	Stoke's theorem- definition and problems	
UNIT 4	**Basics of Graph theory**	**15 Hours**
4.1	Basic definitions, Isomorphism, Sub graphs	
4.2	Operations on graphs	
4.3	Walks, Paths, Circuits, Connected and disconnected graphs	
4.4	Euler graphs, Hamiltonian graphs, Some applications	
4.5	Trees – Basic properties, Distance, Eccentricity, centre, Spanning trees, Minimal spanning tree	

REFERENCE BOOKS:

1.	C.L. Liu(200), Elements of Discrete Mathematics, Tata Mc Graw- Hill.
2.	Frank Harary (1969), Graph theory, Addison –Wesley Pub, Company
3.	Hari Kishan and Shiv Raj Pundir (2015), Discrete Mathematics, Pragathi Prakashan, 10^{th} ed
4.	I.N. Herstein (1990), Topics in Algebra, 2^{nd} Edition, Wiley Eastern Ltd., New Delhi
5.	Joseph A. Gallian(2021), Contemporary Abstract Algebra, 10^{th} ed., Taylor and Francis Group
6.	Kenneth H.Rossen, Discrete Mathematics and its Applications, Mc- Graw-Hill, 8^{th}
	ed., 2021
7.	Michael Artin (2015), Algebra, 2^{nd} ed., Pearson.
8.	Murray R Spiegel – The ory and problems of vector calculus
9.	N. Deo(1990), Graph Theory; Prentice, Hall of India Pvt.Ltd,.New Delhi
10.	Shanthinarayan and J N Kapur – A text book of Vector calculus
11.	Vijay K Khanna and SK Bhambri(1998), A Course in Abstract Algebra, Vikas Publications
12.	W D Wallis (2017), A Beginner's Guide to Discrete Mathematics for Computer Science, Wiley Publishers

Title	PRACTICAL'S ON ADVANCED ALGEBRA AND DISCRETE MATHEMATICS
Code	MATDSCP502
Teaching Hours: 4 Hours/week	Credits: 2
Total Teaching hours:60 Hours	Max. Marks: 50 (S.A. :25 + I.A. :25)

Course Learning Outcome:

This course will enable the students to	
CLO-1	Learn *Free and Open Source Software (FOSS)* tools for computer programming.
CLO-2	Solve problem on Advanced Algebra and Discrete Mathematics studied in **MATDSCT 502 by** using FOSS software's.
CLO-3	Acquire knowledge of applications of Advanced Algebra and Discrete Mathematics through FOSS

Practical/Lab Work to be performed in Computer Lab (FOSS)
Suggested Software's: Maxima/Scilab/Python/R.

1	(i) To Verify the given Ring is Commutative or not. (ii) To check the Presence of the Unity element in the Ring
2	(i)To verify the given Ring ia a Field /Integral Domain or not.(ii)To verify given set is a Sub ring of a Ring or not
3	To verify given function is a homomorphism or not
4	(i) To verify the given polynomial is reducible or irreducible.(ii) To find the zeros of the given polynomial
5	To find the G.C.D of any two polynomials
6	i) To find the Units of the given ring. ii) To verify the given elements are Associates or not.
7	Graph Theory
8	Maxima program to obtain some standard graphs
9	Create a graph of your choice
10	Obtain Induced sub graph
11	Obtain random graph
12	To check the given are graphs are isomorphic or not
13	Obtain degree of each vertices
14	Obtain distance between vertices
15	Obtain eccentricity of vertices
16	Operation on graph: Product of graphs
17	Maximum/ Minimum degree vertices of the graph G and a vertex of maximum/ minimum degree
18	Obtain radius and diameter of the graph
19	Obtain Edge connectivity and Vertex connectivity
20	Obtain minimum spanning tree
21	Obtain Adjacency matrix of the graph

Semester VI

Core Course Content

Course Title: Linear Algebra	**Course Credits**: 04
Course Code: MATDSC601	**L-T-P per week**: 4:0:0
Total Contact Hours: 64 Hours	

Formative Assessment Marks: 40	**Summative Assessment Marks**: 60

Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar/Field studies

Formative Assessment		
Assessment	**Assessment type**	**Weightage in Marks**
C1 First component	Test	10
C1 Second Component	Assignment	10
C2 First Component	Seminar	10
C2 Second Component	E-content	10

Course Objectives:

1. **Understand and Apply the Theory of Vector Spaces:**
   Students will gain a thorough understanding of vector spaces, including their definitions, examples, and key properties. They will explore subspaces, linear combinations, and the concepts of linear dependence and independence. Students will develop the ability to determine linear dependence and independence in various vector spaces and understand quotient spaces, including their theorems and examples.
2. **Study Linear Transformations and Matrix Representations:**
   Students will learn the theory of linear transformations, including definitions, examples, and equivalent criteria. They will study the matrix representation of linear transformations, understand the effects of change of basis on matrices, and explore similar matrices. The course will also cover the Rank-Nullity Theorem, and students will be able to apply it to solve problems involving the null space and range space of transformations.
3. **Explore Eigenvalues, Eigenvectors, and Diagonalization:**
   Students will learn to compute eigenvalues and eigenvectors, understand their algebraic and geometric multiplicities, and explore the concepts of eigen spaces. They will study the diagonalizability of linear transformations, verifying the conditions for diagonalization based on the relationship between algebraic and geometric multiplicity. The course will also cover invertible transformations and their basic properties.
4. **Study Inner Product Spaces and Invertible Transformations:**
   Students will understand the concept of singular and non-singular transformations and the conditions under which inverses exist. They will study the minimal polynomial of a transformation and explore its relationship with the characteristic polynomial. Additionally, students will be introduced to inner product spaces, norms, and the Cauchy-Schwartz inequality. The course will culminate with the Gram-Schmidt orthogonalization process, including both theoretical understanding and problem-solving skills**.**

Course Outcomes: Upon completing the course, students will be able to

1. define and work with vector spaces and subspaces, demonstrating an understanding of their properties. They will be able to determine linear dependence and independence of vectors in various

vector spaces, apply the concepts of linear combinations and linear span, and solve problems involving quotient spaces.

2. define and identify linear transformations, understand their matrix representations, and apply the Rank-Nullity Theorem to solve problems involving null space and range space. They will also develop the ability to analyze changes of basis and the effect of basis transformations on the associated matrix, and understand the concept of homomorphism, isomorphism, and automorphism.
3. compute eigenvalues and eigenvectors, determine their algebraic and geometric multiplicities, and verify the diagonalizability of linear transformations. They will also understand and apply the concept of invertible transformations, recognizing their key properties and significance in the context of linear algebra.
4. understand inner product spaces, norms, and the Cauchy-Schwartz inequality, and will be able to apply these concepts to solve problems. They will also develop proficiency in orthogonality, constructing orthonormal bases using the Gram-Schmidt process, and applying it to problems in linear algebra and geometry.

Course Content:

UNIT 1	**VECTOR SPACES**	**15 Hours**
1.1	Vector spaces - Definition, examples and properties	
1.2	Subspaces - Examples, criterion for a subspace and some properties	
1.3	Linear Combination , Linear span	
1.4	Linear dependence and Linear independence, basic properties of linear dependence and independence, techniques of determining linear dependence and independence in various vector spaces and related problems.	
1.5	Quotient space- theorems and examples.	
UNIT 2	**LINEAR TRANSFORMATIONS**	**15 Hours**
2.1	Linear transformation - Definition, examples, equivalent criteria, some basic properties.	
2.2	Matrix representation of a linear transformation, change of basis and effect on associated matrix, similar matrices	
2.3	Rank - Nullity theorem -Null space, Range space, proof of rank nullity theorem and related problems.	
2.4	Homomorphism, Isomorphism and automorphism-Examples, order of automorphism.	
2.5	Fundamental theorem of homomorphism	
UNIT 3	**EIGEN VALUES , DIAGONALIZATION**	**15 Hours**
3.1	Eigen values and Eigen vectors -Computation of Eigen values, algebraic multiplicity, some basic properties of eigen values	
3.2	Determination of eigen vectors and eigen space and geometric multiplicity	
3.3	Diagonalizability of linear transformation - Meaning, condition based on algebraic and geometric multiplicity (mentioning) and related problems (Only verification of diagonalizability).	
3.4	Invertible transformation - some basic properties of Invertible	
UNIT 4	**INVERTIBLE TRANSFORMATION AND INNER PRODUCT SPACES**	**15 Hours**
4.1	Singular and non-singular transformations and conditions for existence of inverses.	

4.2	Minimal polynomial of a transformation**.** Relation between characteristic and minimal polynomials and related problems.	
4.3	Inner product and normed linear spaces- Definitions, examples, Cauchy-Schwartz inequality (with proof) and related problems.	
4.4	Gram-Schmidt orthogonalization-Orthogonal vectors, orthonormal basis, Gram-Schmidt orthogonalization process: both proof and problems.	

REFERENCE BOOKS:

1.	F.M.Stewart, *Introduction to Linear Algebra*, Dover Publications.
2.	Gilbert.Strang (2015), Linear Algebra and its applications, (2ndEdition), Elsevier
3.	I. N. Herstein, *Topics in Algebra*, 2nd Edition,Wiley.
4.	Kenneth Hoffman & Ray Kunze (2015), Linear Algebra, (2ndEdition), Prentice Hall India Leaning Private Limited
5.	Serge Lang (2005), Introduction to Linear Algebra (2ndEdition), Springer India.
6.	S.Kumaresan, *Linear Algebra*, Prentice Hall India Learning Private Limited.
7.	Stephen H. Friedberg, Arnold J.Insel & Lawrence E.Spence (2003), Linear Algebra (4thEdition), Printice-Hall of India Pvt.Ltd.
8.	T.K.Manicavasagam Pillai and K S Narayanan, Modern Algebra Volume2
9.	VivekSahai &VikasBist (2013), Linear Algebra (2ndEdition) Narosa Publishing.

Title	PRACTICAL'S ON LINEAR ALGEBRA
Code	MATDSCP601
Teaching Hours: 4 Hours/week	Credits: 2
Total Teaching hours:60 Hours	Max. Marks: 50 (S.A. :25 + I.A. :25)

Course Learning Outcome:

This course will enable the students to	
CLO-1	Learn *Free and OpenSource Software (FOSS)* tools for computer programming.
CLO-2	Solve problem on Linear Algebra studied in **MATDSCT 6.1 by** using FOSS software's.
CLO-3	Acquire knowledge of applications of Linear Algebra through FOSS

Practical/Lab Work to be performed in Computer Lab (FOSS)
Suggested Software's: Maxima/Scilab/Python/R.

1	Program on linear combination of vectors.
2	Program to verify linear dependence and independence.
3	Program to find basis and dimension of the subspaces.
4	Program to verify the function is linear transformation or not.
5	Program to find the matrix of linear transformation.
6	Program to find the Eigen values and Eigen vectors of a given linear transformation.
7	Program on Rank–nullity theorem.
8	Program to verify if the given linear transformation is singular/non-singular.
9	Program to find the minimal polynomial of given transformation.
10	Program to find the algebraic multiplicity of the Eigen values of the given linear transformation.
11	Program on diagonalization

Semester VI
Core Course Content

Course Title: Numerical Analysis	**Course Credits**: 04
Course Code: MATDSC602	**L-T-P per week**: 4:0:0

Total Contact Hours: 64 Hours	
Formative Assessment Marks:40	**Summative Assessment Marks**:60

Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar/Field studies

Formative Assessment		
Assessment	**Assessment type**	**Weightage in Marks**
C1 First component	Test	10
C1 Second Component	Assignment	10
C2 First Component	Seminar	10
C2 Second Component	E- Content	10

Course Objectives:

1. **Understand and Apply Error Analysis:**
   Students will learn the fundamental concepts of errors, including absolute, relative, and percentage errors. They will also gain an understanding of rounding off, truncation errors, and general error formulas. The course will provide students with the tools to analyze errors in numerical computations, particularly in Taylor series approximations, and apply error analysis in practical problem-solving.
2. **Master Methods for Solving Algebraic and Transcendental Equations:**
   Students will gain proficiency in solving algebraic and transcendental equations using numerical methods. They will explore various root-finding techniques, including the Bisection method, Regula-Falsi method, Newton-Raphson method, and Secant method, understanding their rationale, convergence properties, and applications in solving real-world problems.
3. **Explore Solutions to Systems of Linear Equations:**
   Students will develop skills in solving systems of linear algebraic equations using both direct and iterative methods. They will study direct methods such as the Gauss elimination and Gauss-Jordan methods, along with iterative methods like Jacobi, Gauss-Seidel, and Successive Over-Relaxation (SOR) methods, understanding their convergence properties and applying them to solve large systems.
4. **Apply Numerical Techniques in Polynomial Interpolation, Differentiation, and Integration:**
   Students will acquire knowledge of polynomial interpolation techniques, including Newton-Gregory, Gauss's Forward and Backward interpolation, and Lagrange interpolation polynomials. They will also explore numerical differentiation and integration methods, including the Trapezoidal rule, Simpson's 1/3 rule, and Simpson's 3/8 rule, with a focus on their derivations, applications, and solving practical problems in numerical analysis.

Course Outcomes: Upon completion of the course , student will be able to

1. identify and analyze different types of errors, such as absolute, relative, and percentage errors. They will be able to apply error analysis techniques to assess the accuracy of numerical solutions and approximate methods, including Taylor series approximations, and understand the implications of errors in computational mathematics.
2. solve algebraic and transcendental equations using various numerical methods, including the Bisection method, Regula-Falsi method, Newton-Raphson method, and Secant method. They will be proficient in selecting appropriate methods based on the problem type, evaluating the convergence of methods, and solving real-world problems requiring numerical root-finding.
3. gain the ability to solve systems of linear algebraic equations using both direct methods (such as Gauss elimination, Gauss-Jordan, and Triangularization methods) and iterative methods (such as Jacobi, Gauss-Seidel, and Successive Over-Relaxation methods). They will be able to apply these methods to large-scale systems and evaluate the efficiency and convergence of iterative techniques.
4. apply polynomial interpolation techniques, including Newton-Gregory and Lagrange interpolation, to estimate values of functions. They will also be skilled in using numerical differentiation and integration methods, such as the Trapezoidal rule, Simpson's rules, and Weddell's rule, to approximate derivatives and integrals for a variety of functions, ensuring accurate results for practical applications.

Course Content:

UNIT 1	**Algebraic and Transcendental Equations**	**15 Hours**
1.1	Errors- Significant digits, absolute, relative, percentage errors, rounding off and truncation errors (meanings and related problems)	
1.2	General error formula (derivation of formula and problems based on it), error in series approximation: Taylor series approximations (problems only)	
1.3	Solutions to algebraic and transcendental equations - Bisection method, Regula-Falsi method	
1.4	Iterative method	
1.5	Newton-Raphson method	
1.6	Secant method (Plain discussion of the rationale behind techniques and problems on their applications)	
UNIT 2	**System of Linear Algebraic Equations**	**15 Hours**
2.1	Direct Methods– Gauss elimination method	
2.2	Gauss-Jordan elimination method and Triangularization method	
2.3	Iterative methods – Jacobi method	
2.4	Gauss-Jacobi method, Gauss-Seidel method	
2.5	Successive- Over Relaxation method (SOR) method	
UNIT 3	**Polynomial Interpolations**	**15 Hours**
3.1	Finite differences**.** Forward, backward and central differences	
3.2	Shift operators: definitions, properties and problems	
3.3	Polynomial interpolation - Newton-Gregory forward and backward interpolation formulas	
3.4	Gauss's Forward and backward interpolation formulas, Lagrange interpolation polynomial	
3.5	Newton's divided differences and Newton's general interpolation formula (Discussion on setting up the polynomials, differences between them and problems on their applications).	
UNIT 4	**Numerical Differentiation and Integration**	**15 Hours**

4.1	Formula for derivatives (till second order) based on Newton-Gregory forward and backward interpolations (Derivations and problems based on them).	
4.2	Numerical Integration-General quadrature formula (derivation)	
4.3	Trapezoidal rule (Derivation and problems)	
4.4	Simpson's1/3rule (Derivation and problem), Simpson's 3/8 rule (problem only)	
4.5	Weddel's rule (Problem only)	

REFERENCE BOOKS:

1	E.Isaacson and H.B.Keller, *Analysis of Numerical methods*, Dover Publications
2	S.S. Sastry, *Introductory methods of Numerical Analysis*, 5thEdition, PHI Learning Private Limited.
3	E Kreyszig, *Advanced Engineering Mathematics*, Wiley India Pvt.Limited
4	B.S. Grewal, *Numerical Methods for Scientists and Engineers*, Khanna Publishers.
5	M.K.Jain, S.R.K. Iyengar and R.K.Jain, *Numerical Methods for Scientific and Engineering computation,* 4thEdition, New Age International
6	H.C.Saxena, *Finite Difference and Numerical Analysis,* S.Chand Publishers
7	B.D.Gupta, *Numerical Analysis*, Konark Publishers Pvt.Ltd.

Title	**PRACTICAL'S ON NUMERICAL ANALYSIS**	
Code	**MATDSCP601**	
Teaching Hours: 4 Hours/week		**Credits: 2**
Total Teaching hours:60 Hours		**Max. Marks: 50** **(S.A. :25 + I.A. : 25)**

Course Learning Outcome:

This course will enable the students to	
CLO-1	Learn *Free and Open Source Software (FOSS)* tools for computer programming.
CLO-2	Solve problem on Linear Algebra studied in **MATDSCT 6.1 by** using FOSS software's.
CLO-3	Acquire knowledge of applications of Linear Algebra through FOSS

Practical/Lab Work to be performed in Computer Lab (FOSS)
Suggested Software's: Maxima/Scilab/Python/R.

1.	Program to find root of an equation using bisection and Regula-Falsi methods
2.	Program to find root of an equation using Newton-Raphson and Secant methods
3.	Program to solve system of algebraic equations using Gauss-elimination method.
4.	Program to solve system of algebraic equations using Gauss-Jordan method.
5.	Program to solve system of algebraic equation using Gauss-Jacobi method
6.	Program to solve system of algebraic equation using Gauss-Seidel method.
7.	Program to solve the system of algebraic equations using SOR method
8.	Program to evaluate integral using Simpson's 1/3 and 3/8 rules.
9.	Program to evaluate integral using Trapezoidal and Weddle rules.
10.	Program to find the sums of powers of successive natural numbers usingNewton–Gregory technique.
11.	Program to find differentiation at specified point using Newton-Gregory interpolation method
12.	Program to find the missing value of table using Lagrange method

Blue print

_ **Time: 2 and half hours** **Max. Marks: 60**

Section	Sub Section		Marks
		Part A	
1		**Answer any THREE of the following questions:**	3x5=15
	a.		
	b.		
	c.		
	d.		
	e.		
		Part B	
2		**Answer any THREE of the following questions:**	3x5=15
	a.		
	b.		
	c.		
	d.		
	e.		
		Part C	
3		**Answer any THREE of the following questions:**	3x5=15
	a.		
	b.		
	c.		
	d.		
	e.		
		Part D	
4		**Answer any THREE of the following questions:**	3x5=15
	a.		
	b.		
	c.		
	d.		
	e.		