BANGALORE UNIVERSITY

DEPARTMENT OF MATHEMATICS

Syllabus

For

V and VI Semester B.Sc-Mathematics

With effect from

Academic Year 2023-2024

PROCEEDINGS OF THE BOS IN MATHEMATICS(UG) MEETING HELD ON 04, SEPTEMBER 2023 IN THE DEPARTMENT OF MATHEMATICS, BANGALORE UNIVERSITY, JNANABHARATHI, BENGALURU-56 AT 12.30 PM

The chairperson welcomed all the members to the BOS meeting. The agenda of the meeting were taken up for discussions. The final resolutions of the meeting are as mentioned below:

1. Board recommended the names of the new teachers to the BOE-Panels for UG(B.Sc)-Mathematics and UG-Professional (B.Tech)-Mathematics exams 2023-24 based on their service.
2. The panels of Examiners were revised, updated with the inclusion of new eligible teachers and both the panels were approved.
3. The BOS had a discussion on the draft syllabus for V and VI semester B.Sc. and approved the same after necessary corrections.
4. Internship in the VI semester from the institutes/industries.

Sl. No.	Members of the BOS present in the meeting		Signature of the members
1.	Dr. H. G. Nagaraja	Chairman	[signature]
2.	Mr. H. S. Mahesh	Member	[signature]
3.	Dr. Shailaja M	Member	[signature]
4.	Mrs. Jyothi D K	Member	[signature]
5.	Mrs. Mamatha H K	Member	[signature]
6.	Dr. Jagadeesh R	Member	[signature]
7.	Mr. T. R. Marulasiddappa	Member	T.R.Marulasiddappa
8.	Dr. Balbheem Saibanna	Member	[signature]
9.	Dr. Shobhankumar D M	Member	[signature]

The chairman thanked all the members for extending their help and co-operation in this regard.

[signature]
CHAIRMAN
BOS IN MATHEMATICS(UG)
Professor & Chairman
Department of Mathematics
Bangalore University

Name of the Degree Program : **B.Sc.**
Discipline Course : **Mathematics**
Starting Year of Implementation : **2021-22 (I & II Semesters)**
2022-23 (III & IV Semesters)
2023-24 (V & VI Semesters)

Programme Outcomes (PO)	
	By the end of the program the students will be able to:
PO 1	**Disciplinary Knowledge** Studying related areas such as computer science and other allied subjects as a Bachelor's degree in Mathematics is the culmination of in-depth knowledge of Algebra, Calculus, Geometry, Differential Equations, and several other branches of pure and applied mathematics.
PO 2	**Nature of Mathematics:** Understand the concise, precise, and rigorous nature of Mathematics.
PO 3	**Communication Skills**: Communicate various mathematical concepts effectively using examples and their geometrical visualization. The skills and knowledge gained in this program will lead to proficiency in analytical reasoning, which can be used for modeling and solving real-life problems.
PO 4	**Critical Thinking and Analytical Reasoning:** Acquire the ability of critical thinking and logical reasoning and the capability of recognizing and distinguishing the various aspects of real-lifeproblems.
PO 5	**Problem Solving:** Analyze the problems and identifyand define appropriate computing requirements for its solutions. This programme enhances students' overall development and equips them withmathematical modeling ability and problem-solving skills.
PO 6	**Research related skills:** Develop the capability of inquiring about appropriate questions relating to the Mathematical concepts in different areas of Mathematics.
PO 7	**Information/digital Literacy**: Use appropriate software's to solve system of algebraic equation and differential equations.

PO 8	**Self–directed learning**: Work independently and make an in-depth study of various notions of Mathematics.
PO 9	**Moral and ethical awareness/reasoning:** Identify unethical behavior such as fabrication, falsification, or misinterpretation of data and adopting objectives, unbiased and truthful actions in all aspects of life in general and Mathematical studies in particular.
PO 10	**Life long learning:** Have self-directed learning and lifelong learning skills. This programme helps learners think independently and develop algorithms and computational skills to solve real-world problems.
PO 11	**Higher Studies:** Peruse advanced studies and research in pure and applied Mathematical sciences.
PO 12	**Employability:** Know how the program helps enhance employability for jobs in banking, insurance, and investment sectors, data analysis, and various other public and private enterprises.

ASSESSMENT

Weightage for the Assessments (in percentage)

Type of Course	Formative Assessment/I.A.	Summative Assessment (S.A.)
Theory	40 Marks C.1 Sessional Tests: 10 Marks C.2 Assignments/Seminars: 20 Marks C.3 Sessional Test: 10 Marks	60 Marks
Practical	25 Marks C.1 Sessional Tests- 20 Marks C.2 Assignment- 5 Marks	25 Marks
Experiential Learning (Internship etc.)	--	--

COURSES OFFERED

Semester	Course No.	Theory/ Practical	Credits	Paper Title	Marks in percentage	
					S.A.	I.A.
V	MATDSCT 5.1	Theory	4	Real Analysis-II and Complex Analysis	60	40
	MATDSCP 5.1	Practical	2	Theory based Practical's on Real Analysis-II and Complex Analysis	25	25
	MATDSCT 5.2	Theory	4	Vector Calculus and Analytical Geometry	60	40
	MATDSCP 5.2	Practical	2	Theory based Practical's on Vector Calculus and Analytical Geometry	25	25
VI	MATDSCT 6.1	Theory	4	Rings, Fields, and Linear Algebra	60	40
	MATDSCP 6.1	Practical	2	Theory based Practical's on Rings, Fields, and Linear Algebra	25	25
	MATDSCT 6.2	Theory	4	Numerical Analysis	60	40
	MATDSCP 6.2	Practical	2	Theory based Practical's on Numerical Analysis	25	25

SEMESTER – V

MATDSCT 5.1: REAL ANALYSIS-II AND COMPLEX ANALYSIS	
Teaching Hours: 4 Hours/Week	Credits: 4
Total Teaching Hours: 60 Hours	Max. Marks: 100 (S.A. 60 + I.A. 40)

Course Outcomes:

The overall expectation from this course is that the student builds a basic understanding of Riemann integration and elementary complex analysis. At the end of this course, the student will be able to:

CO1 Understand Riemann integrals their properties and describe various criteria for integrability of functions.

CO2 Have an overview of the gamma and beta functions and their relation to a variety of integrals.

CO3 Comprehend the fundamental concepts of analytic functions, including the Cauchy-Riemannequations and orthogonal systems.

CO4 Analyze the proof of Cauchy's Integral theorem using Green's theorem and understand its implications.

CO5 Analyze elementary transformations such as translation, rotation, magnification and inversion.

REAL ANALYSIS – II

Unit–I: Riemann Integration-I

Definition & examples for partition of an interval, refinement of a partition, and common refinement.

Riemann Darboux Sums: Upper and lower(Darboux) sum-definition, properties & problems.

Riemann Integral: Upper and Lower integrals (definition & problems), Darboux's theorem and Criterion for Integrability, Integrability of sum, difference, product, quotient, and modulus of integrable functions.

Integral as a limit of sum (Riemann sum)-Problems.

Some integrable functions: Integrability of continuous functions, monotonic functions, bounded functions with a finite number of discontinuity. **15 Hours**

Unit –II: Improper Integrals

Improper Integrals: -Improper integrals of the first, second, and third kind with examples. Improper integral as the limit of proper integral.

Beta-Gamma Functions: -Definitions, Properties, and examples, relations between beta and gamma functions, standard theorems, applications of definite integrals, duplication formula, and its applications. **15 Hours**

COMPLEX ANALYSIS

Unit – III: Complex numbers and functions of complex variables:

Complex numbers- Cartesian and polar form-geometrical representation-Complex-Plane-Euler's formula-$e^{i\theta} = \text{Cos}\theta + i\text{Sin}\theta$. Functions of a Complex variable-limit, Continuity and Differentiability of a Complex function. Analytic function, Cauchy-Riemann equations in Cartesian forms (Cartesian form only)- Harmonic function-standard properties of analytic functions-construction of analytic function when the real or imaginary part is given-Milne Thomson method. **15 Hours**

Unit –IV: Complex Integration and Transformations:

Complex Integration: Definition, Line integral, properties, and problems. Cauchy's Integral theorem-proof using Green's theorem-direct consequences. Cauchy's Integral formula with proof -Cauchy's generalized formula for the derivatives with proof and applications for evaluation of simple line integrals.

Transformations: Linear Transformation-Definitions-Bilinear transformations, Cross-ratio of four points-Cross-ratio preserving property-Preservation of the family of straight lines and circles-Conformal Mappings-Discussion of the transformations. $w = \frac{1}{z}$, $w = \sin z$, $w = \cos z$, $w = e^z$. **15 Hours**

FORMULATION OF COURSE ARTICULATION MATRIX:

Course Articulation Matrix correlates the individual COs of a course with POs and PSOs. The strength of correlation is indicated as 3 for substantial (high) 2 for correlation, moderate (medium) correlation, and 1 for slight (low) correlation.

COURSE ARTICULATION MATRIX

MATDSCT 5.1 : REAL ANALYSIS-II AND COMPLEX ANALYSIS												
Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	2	2	-	1	-	1	1	-
CO2	2	1	-	1	2	1	-	1	-	-	-	-
CO3	2	1	1	1	1	1	1	2	-	1	-	-
CO4	2	2	1	1	-	-	-	-	-	-	1	-
CO5	2	2	-	2	2	-	-	-	-	-	1	-

REFERENCE BOOKS:

1. S. C. Malik and Savita Arora, Mathematical Analysis, 6^{th} ed.: New Age International (P) Ltd. 2021.
2. R. R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing, 2020.
3. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 4ed, Wiley, 2021.
4. Ajit Kumr and S. Kumaresan - A Basic Course in Real Analysis, Taylor and Francis Group, 2014.
5. W. Rudin, Principles of Mathematical Analysis, 3^{rd} Edition, McGraw Hill Education, 2017.
6. L. V. Ahlfors, Complex Analysis, 3^{rd}, McGraw Hill Education, 1978.
7. B. P. Palka, Introduction to the Theory of Function of a Complex Variable, Springer, 2012.
8. S. Lang, Complex Analysis, 4^{th} ed. Springer, 2003.
9. Shanthinarayan and P. K. Mittal, Theory of Functions of a Complex Variable, 2^{nd} ed. S. Chand Publishers, 2005.
10. S. Ponnuswamy, Foundations of Complex Analysis, 2^{nd} ed., Narosa, 2011.
11. J. W. Brown & R. V. Churchill, Complex Variables and Applications, 8^{th} ed, McGraw Hill Companies, 2017.

WEB RESOURCES:

1. https://nptel.ac.in/courses/109104124

MATDSCP 5.1: PRACTICAL'S ON REAL ANALYSIS-II AND COMPLEX ANALYSIS	
Practical Hours: 4 Hours/Week	**Credits: 2**
Total Practical Hours: 60 Hours	**Max. Marks: 50 (S.A. 25 + I.A. 25)**

Course Outcomes:

This course will enable the students to

- CO1 Learn Free and Open-Source Software (FOSS) tools for computer programming
- CO2 Solve the problem of Real Analysis, and Complex Analysis studied in **MATDSCT 5.1by** using FOSS software's.
- CO3 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.

Suggested Programs:

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 a givenpartition.
3. Program to test Riemann Integrability.
4. Program to evaluate Riemann integral as a limit of sum.
5. Evaluation of the integrals using the Gamma function.
6. Evaluation of the integrals using the Beta function.
7. Program on verification of Cauchy–Riemann equations (Cartesian form)or test for analyticity.
8. Program to check whether a function is harmonic or not.
9. Program to construct analytic functions (through the Milne–Thompson method).
10. Program to find a Cross-ratio of four points.

COURSE ARTICULATION MATRIX

MATDSCP 5.1 : PRACTICALS ON REAL ANALYSIS-II AND COMPLEX ANALYSIS												
Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	2	3	2	3	3	-	3	2	3
CO2	2	-	-	2	3	1	2	1	-	2	2	1
CO3	1	1	1	-	2	3	-	1	-	1	2	1

REFERENCES:

1. Python: The Complete Reference IV Edition 2018, Martin C. Brown, Mc. Graw Hill Publication.
2. https://www.geeksforgeeks.org/python-math-library-gamma-function/

MATDSCT 5.2: VECTOR CALCULUS AND ANALYTICAL GEOMETRY	
Teaching Hours: 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max. Marks: 100 (S.A. 60 + I.A. 40)**

Course Outcomes:

This course will enable the students to

CO1 Get introduced to the fundamentals of vector differential and integral calculus.

CO2 Get familiar with the various differential operators and their properties.

CO3 Get acquainted with the various techniques of vector integration.

CO4 Learn the applications of vector calculus.

CO5 Recollect the fundamentals of Analytical Geometry and interpret the geometrical aspects of planes and lines in 3D.

VECTOR CALCULUS

Unit – I: Vector Algebra

Vector Algebra: Multiple product – scalar triple product, vector triple product, geometrical interpretation, related problems, vector function of a scalar variable – interpretation as a space curve, derivative, tangent, normal, and binormal vectors to a space curve.

Scalar field: Gradient of a scalar field, geometrical meaning, directional derivative, unit normal to the surfaces - tangent plane and normal to the surface.

Vector field: Divergence and curl of a vector field, solenoidal and irrotational fields, Laplacian of a scalar field, Vector identities. **15 Hours**

Unit – II: Vector Integration

Vector Integration – Definition and basic properties, vector line integral, surface integral, and volume integral; **Green's theorem in the plane** – Proof and related problems; **Gauss' Divergence theorem** – Proof and related problems; **Stokes' theorem** – Proof and related problems. **15 Hours**

ANALYTICAL GEOMETRY

Unit-III: Planes, Straight Lines and Spheres

Planes: Distance of a point from a plane, Angle between two planes, pair of planes, Bisectors of angles between two planes.

Straight Lines: Equations of straight lines, Distance of a point from a straight line, Distance between two Straight lines, Distance between a straight line and a plane.

Spheres: Different forms, Intersection of two Spheres, Orthogonal intersection. **15 Hours**

Unit-IV: **Curves and Surfaces**

Locus of a point, Algebraic Curves, Conicoid Space Curves, Ruled Surfaces, Classification of quadric surfaces, Cone, Cylinder, Central Conicoid, Tangent plane, Normal, Polar planes, and Polar lines. **15 Hours**

COURSE ARTICULATION MATRIX

MATDSCT 5.2 : VECTOR CALCULUS AND ANALYTICAL GEOMETRY												
Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	1	-	1	-	-	-	1	-	-
CO2	2	1	-	1	1	-	-	1	-	-	1	-
CO3	1	2	1	1	2	1	-	1	-	1	1	1
CO4	1	2	2	2	2	1	1	1	-	2	2	1
CO5	2	2	1	2	1	1	-	1	-	-	-	-

REFERENCE BOOKS:

1. M. D. Raisinghania, Vector Calculus, S. Chand Co.Pvt.Ltd.,2013.
2. M. Spiegel, Vector Analysis, 2nd Edition, Schaum's Outline Series, McGraw Hill Education, 2017.
3. C. E. Weatherburn, Elementary Vector Analysis, Alpha edition, 2019.
4. B. S. Grewal, Higher Engineering Mathematics, 42nd Edition Khanna Publishers, 2017.
5. R. J. T. Bell, An Elementary Treatise on Coordinate Geometry of Three Dimensions, Macmillan India Ltd, 2018.
6. D. Chatterjee, Analytical Geometry: Two and Three Dimensions, Narosa Publishing House, 2009.
7. Shanthi Narayan and P. K. Mittal, Analytical Solid Geometry, 17th ed. S. Chand Company, 2017.

8. A. N. Das, Analytical Geometry of Two and Three Dimensions, 1st ed., New Central Book Agency Pvt. Ltd, 2009.
9. P. N. Wartikar and J. N. Wartikar, A Textbook of Applied Mathematics, Vol. II, Pune Vidyarthi Griha Prakashan, 2008.
10. C. E. Weatherburn, Differential Geometry of Three Dimensions-1, Hassell Street Press, 2021.
11. G. B. Thomas and R.L. Finney, Introduction to Calculus and Analytical Geometry, Narosa Publishing House, 2010.

WEB RESOURCES:

1. https://ocw.mit.edu/courses/res-18-007-calculus-revisited-multivariable-calculus-fall-2011/resources/lecture-6-equations-of-lines-planes/

MATDSCP 5.2: PRACTICAL'S ON ANALYTICAL GEOMETRY AND VECTOR CALCULUS	
Teaching Hours: 4 Hours/Week	**Credits: 2**
Total Teaching Hours: 60 Hours	**Max. Marks: 50 (S.A. 25 +I.A. 25)**

Course Outcomes:

This course will enable the students to

CO1 Learn Free and Open-Source Software (FOSS) tools for computer programming

CO2 Solve problems related to Analytical Geometry and Vector Calculus usingFOSS software.

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

Suggested Programs:

1. Program on multiple products of vectors – Scalar and cross-product.
2. Program on vector differentiation and finding unit tangent.
3. Program to find the gradient and Laplacian of a scalar function.
4. Program to find the divergence and curlof a vector function.
5. Program to evaluate a vector line integral.
6. Program to evaluate a surface integral.
7. Program to evaluate a volume integral.
8. Program to verify Green's theorem.
9. Program to verify Gauss' Divergence theorem
10. Program to verify Stokes' theorem
11. Program to find equation and plot sphere, cone, and cylinder
12. Program to find distance between a straight line and a plane.

COURSE ARTICULATION MATRIX

MATDSCP 5.2 : PRACTICALS ON ANALYTICAL GEOMETRY AND VECTOR CALCULUS												
Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	2	3	2	3	3	-	-	3	2	3
CO2	1	1	-	3	3	2	2	2	-	2	1	2

REFERENCES:

1. M. C. Brown, Python: The Complete Reference IV Edition 2018, Mc. Graw Hill Publication.

2. https://computationalmindset.com/en/mathematics/integral-calculus-in-python.html

SEMESTER – VI

MATDSCT 6.1: RINGS, FIELDS, AND LINEAR ALGEBRA	
Teaching Hours: 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max. Marks: 100 (S.A. 60 + I.A. 40)**

Course Outcomes:

The overall expectation from this course is that the student will build a basic understanding of a few areas of linear algebra, such as vector spaces, linear transformations, and inner product spaces. At the end of this course, the student will be able to

CO1 Understand the concepts of Vector spaces, subspaces, bases dimension, and theirproperties.

CO2 Become familiar with the concepts Eigen eigenvalues and eigenvectors, minimalpolynomials, linear transformations, etc.

CO3 Learn properties of inner product spaces and determine orthogonality in innerproduct spaces.

CO4 Prove various statements in the context of vector spaces.

CO5 Realize the importance of adjoint of a linear transformation and its canonical form.

Unit I: Rings, Integral Domains, Fields

Rings:- Definition and properties of rings, Rings of integers modulo n, Subrings, Ideals-Principal, Prime, and Maximal ideals in commutative ring-examples, and standardproperties following the definition.

Homomorphism and Isomorphism: - properties.

Quotient Rings, Integral Domain, **Fields-** properties following the definition, Fundamental Theorem of Homomorphism of Rings, every field is an integral domain, every finite integral domain is a field with examples. **15 Hours**

Unit – II: Vector spaces

Vector spaces: - Definition, examples, and properties.

Subspaces: - Examples, the criterion for a sub-set to be a subspace, and some properties.

Basis and dimension: Linear Combination-Linear span, 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. Co-ordinates, ordered basis, some basic properties of basis and dimension, and subspace spanned by a given set of vectors. **15 Hours**

Unit – III: Linear Transformations

Linear transformation - Definition, examples, equivalent criteria, some basic properties, and matrix representation and change of basis and effect on associated matrix, similar matrices. Null space, Range space, proof of Rank - Nullity theorem, and related problems. **15 Hours**

Unit – IV: Isomorphism, Eigenvalues and Diagonalization

Homomorphism, Isomorphism, and Automorphism- Examples, order of automorphism and Fundamental theorem of homomorphism**.**

Eigenvalues and Eigenvectors - Computation of Eigenvalues, algebraic multiplicity, some basic properties of eigenvalues, determination of eigenvectors and eigen space, and geometric multiplicity.

Diagonalizability of linear transformation - Meaning, condition based on algebraic and geometric multiplicity (mentioning) and related problems (Only verification of diagonalizability). **15 Hours**

COURSE ARTICULATION MATRIX

MATDSCT 6.1 : RINGS, FIELDS, AND LINEAR ALGEBRA												
Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	2	1	2	-	2	-	1	1	1
CO2	2	1	-	2	2	2	1	1	-	1	2	1
CO3	2	2	1	2	2	1	1	1	-	1	1	-
CO4	2	2	2	2	-	1	-	1	-	-	1	-
CO5	2	1	1	1	2	2	-	-	-	-	-	-

REFERENCE BOOKS:

1. I. N. Herstein, Topics in Algebra, 2nd Edition, Wiley, 2006.
2. A. R. Vasishtha, Modern Algebra, 16th Edition, Krishna Prakshan Mandir, 2010.

3. S. H. Friedberg, A. J. Insel and L. E. Spence, Linear Algebra (4th Edition), Prentice-Hall of India Pvt. Ltd, 2003.
4. F. M. Stewart, Introduction to Linear Algebra, Dover Publications, 2019.
5. S. Kumaresan, Linear Algebra, Prentice Hall India Learning Private Ltd., 2000.
6. K. Hoffman and R. Kunze, Linear Algebra, (2nd Edition), Prentice Hall India Leaning Private Ltd. 2015.
7. G. Strang, Linear Algebra and its applications, (2nd Edition), Elsevier, 2015.
8. V. Sahai & V. Bist, Linear Algebra (2nd Edition) Narosa Publishing, 2013.
9. S. Lang, Introduction to Linear Algebra (2nd Edition), Springer India, 2005.

WEB RESOURCES:

1. https://nptel.ac.in/courses/111101115
2. https://ocw.mit.edu/courses/res-18-008-calculus-revisited-complex-variables-differential-equations-and-linear-algebra-fall-2011/resources/ lecture-1-vector-spaces/

MATDSCP 6.1: PRACTICAL'S ON RINGS, FIELDS, AND LINEAR ALGEBRA	
Practical Hours: 4 Hours/Week	**Credits: 2**
Total Practical Hours: 60 Hours	**Max. Marks: 50 (S.A. 25 + I.A. 25)**

Course Outcomes:

This course will enable the students to

CO1 Learn Free and Open-Source Software (FOSS) tools for computer programming.

CO2 Solve the problem on Linear Algebra studied in **MATDSCT 6.1 by** using FOSS software's.

CO3 Acquire knowledge of applications of Linear Algebra through FOSS.

Practical/Lab Work to be performed in Computer Lab (FOSS)

Suggested Softwares: Maxima/Scilab /Python/R.

Suggested Programs:

1. Program on Commutative ring and ring with unity.
2. Program on integral domain and field.
3. Program on Homomorphism of rings.
4. Program on linear combination of vectors.
5. Program to verify linear dependence and independence.
6. Program to find basis and dimension of the subspaces.
7. Program to verify if a function is a linear transformation or not.
8. Program to find the matrix of linear transformation.
9. Program to find the Eigenvalues and Eigenvectors of a given linear transformation.
10. Program on Rank – nullity theorem.

COURSE ARTICULATION MATRIX

MATDSCP 6.1 : PRACTICALS ON RINGS, FIELDS AND LINEAR ALGEBRA												
Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	2	3	2	3	3	-	3	2	3
CO2	1	1	-	2	3	2	3	2	-	2	2	2
CO3	1	1	1	-	2	2	-	2	-	1	2	2

REFERENCES:

1. M. C. Brown, Python: The Complete Reference IV Edition 2018, , Mc. Graw Hill Publication.
2. M. Tsukada, Y. Kobayashi, H. Kaneko, Sin-Ei Takahasi, K. Shirayanagi, M. Noguchi, Linear Algebra with Python: Theory and Applications, Springer Undergraduate Texts in Mathematics and Technology, Springer Nature Singapore, 2023
3. https://github.com/showell/abstract-algebra

MATDSCT 6.2: NUMERICAL ANALYSIS	
Teaching Hours:4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max.Marks:100 (S.A.60 + I.A.40)**

Course Outcomes:

The overall expectation from this course is that the student will be equipped with certain numerical techniques for various computations, such as finding roots, integrals, and derivatives, and the solutions to differential equations. Some broader course outcomes are listed as follows. At the end of this course, the student will be able to

CO1 Describe various operators arising in numerical analysis, such as difference operators, shift operators, and so on.

CO2 Articulate the rationale behind various techniques of numerical analysis, such as finding roots, integrals, and derivatives.

CO3 Reproduce the existing algorithms for various tasks as mentioned previously in numerical analysis.

CO4 Apply the rules of calculus and other areas of mathematics in justifying the techniques of numerical analysis and to solve problems using suitable numerical technique.

CO5 Appreciate the profound applicability of techniques of numerical analysis in solving real-life problems and appreciate the way the techniques are modified to improve the accuracy.

Unit – I: Algebraic and Transcendental Equations

Errors:-Significant digits, absolute, relative, percentage errors, rounding off and truncation errors (meanings and related problems), general error formula (derivation of formula and problems based on it), error in series approximation, Taylor series approximations (problems only).

Solutions to algebraic and transcendental equations: - Bisection method, Secant method, Regula-Falsi method, Newton-Raphson method, and Fixed-point iterative method (Plain discussion of the rationale behind techniques and problems on their applications).

15 Hours

Unit – II: System of Linear Algebraic Equations

Direct Methods- Gauss elimination method, Gauss-Jordan elimination method, and LU-Decomposition method.

Iterative Methods: Jacobi method, Gauss-Seidal method, Successive-Over Relaxation (SOR) method. **15 Hours**

Unit – III: Polynomial Interpolations

Finite Differences: -Forward, backward, and shift operators: definitions, properties, and problems.

Polynomial Interpolation: -Newton-Gregory forward and backward interpolation formulas, Gauss's Forward and backward interpolation formulas. Lagrange interpolation formula, Newton's divided differences, and Newton's general interpolation formula (Discussion on setting up the polynomials, differences between them, and problems on their applications).

15 Hours

Unit-IV: Numerical Differentiation and Integration

Numerical Differentiation: - Formula for derivatives (till second order) based on Newton-Gregory forward and backward interpolations (Derivations and problems based on them).

Numerical Integration: - General quadrature formula, Trapezoidal rule, Simpson's 1/3rd rule, Simpson's 3/8th rule, Weddle's rule and problems. (Derivations for only general quadrature formula, trapezoidal rule, and Simpson's 1/3rd rule and problems on all the formulas). **15 Hours**

COURSE ARTICULATION MATRIX

MATDSCT 6.2 : NUMERICAL ANALYSIS												
Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	1	2	-	-	-	-	-	1	-
CO2	2	2	1	2	2	1	-	1	-	1	2	2
CO3	-	-	-	1	2	1	1	2	-	-	1	1
CO4	1	2	2	3	1	2	1	2	-	3	2	2
CO5	1	2	1	2	2	2	-	1	-	1	1	2

REFERENCE BOOKS:

1. E. Isaacson and H. B. Keller, Analysis of Numerical methods, revised ed. Dover Publications, 2012.
2. S. S. Sastry, Introductory methods of Numerical Analysis, 5th Edition, PHI Learning Private Limited, 2012.
3. E. Kreyszig, Advanced Engineering Mathematics, 10th ed. Wiley India Pvt. Limited, 2015.
4. B. S. Grewal, Numerical Methods for Scientists and Engineers with Programs in C, C++ & MATLAB,11th ed. Khanna Publishers, 2013.
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MATDSCP 6.2: PRACTICAL'S ON NUMERICAL ANALYSIS	
Practical Hours:4 Hours/Week	**Credits: 2**
Total Practical Hours: 60 Hours	**Max. Marks: 50 (S.A. 25 + I.A. 25)**

Course Outcomes:

This course will enable the students to

CO1 Learn Free and Open-Source Software(FOSS)tools for computer programming

CO2 Solve problems on numerical Analysis studied in **MATDSCT6.2 by** using FOSS software's.

CO3 Acquire knowledge of applications of Numerical Analysis through FOSS.

Practical/Lab Work to be performed in Computer Lab(FOSS)

Suggested Software's: Maxima/Scilab/Python/R.

Suggested Programs:

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 Trapezoidal rules.
9. Program to evaluate integral using Weddle rules.
10. Program to evaluate integral using Simpson's 1/3rd rule.
11. Program to evaluate integral using Simpson's 3/8th rule.
12. Program to find differentiation at specified point using Newton-Gregory interpolation method.

COURSE ARTICULATION MATRIX

MATDSCP 6.2 : PRACTICALS ON NUMERICAL ANALYSIS												
Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	2	3	2	3	3	-	3	2	3
CO2	-	-	-	2	3	2	3	2	-	2	2	2
CO3	1	1	-	1	2	2	-	2	-	1	2	2

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4. https://pythonnumericalmethods.berkeley.edu/notebooks/Index.html