**Mathematics VI Semester**

**DSC7: Linear Algebra**

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|---|---|
| Course Title: Linear Algebra | Course code: 21BSC6C13MAL |
| Total Contact Hours: 56 | Course Credits: 04 |
| Internal Assessment Marks: 40 | Duration of SEE: 2 hours |
| Semester End Examination Marks: 60 | |

Course Outcomes (CO's):

**At the end of the course, students will be able to:**

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

1. Understand the concepts of Vector spaces, subspaces, bases dimension and their properties.
2. Become familiar with the concepts Eigen values and eigen vectors, minimal polynomials, linear transformations etc.
3. Learn properties of inner product spaces and determine orthogonality in inner product spaces.
4. Prove various statements in the context of vectors spaces.
5. Realise importance of adjoint of a linear transformation and its canonical form

**DSC7**: **Linear Algebra**

| Unit | Description | Hours |
|---|---|---|
| **1** | **Vector spaces** - Definition, examples and properties; Subspaces - Examples, criterion for a sub- set to be a subspace and some properties; 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; Basis and dimension - Co-ordinates, ordered basis, some basic properties of basis and dimension and subspace spanned by given set of vectors; Quotient space. Dimension of quotient space (derivation in finite case); Sum and Direct sum of subspaces - Dimensions of sum and direct sum spaces (Derivation in finite case). | 11 |
| **2** | **Linear transformation** - Definition, examples, equivalent criteria, some basic properties and matrix representation and change of basis and effect on associated matrix, similar matrices; Rank - Nullity theorem - Null space, Range space, proof of rank nullity theorem and related problems | 11 |
| **3** | **Homomorphism, Isomorphism and automorphism** - Examples, order of automorphism and Fundamental theorem of homomorphism; Eigenvalues and Eigenvectors - Computation of Eigenvalues, algebraic multiplicity, | 12 |

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|---|---|---|
| | some basic properties of eigenvalues, determination of eigenvectors and eigenspace and geometric multiplicity. Diagonalizability of linear transformation - Meaning, condition based on algebraic and geometric multiplicity (mentioning) and related problems (Only verification of diagonalizability) | |
| **4** | **Invertible transformation** - some basic properties of Invertible, singular and non-singular trans- formations and conditions for existence of inverses; Minimal polynomial of a transformation. Relation between characteristic and minimal polynomials and related problems. | 11 |
| **5** | **Inner product and normed linear spaces** - Definitions, examples, Cauchy-Schwartz inequality (with proof) and related problems; Gram-Schmidt orthogonalization - Orthogonal vectors, orthonormal basis, Gram-Schmidt orthogonalization process: both proof and problems; Orthogonal projection - Orthogonal projection of a vector and a subspace on another subspace, problems related to the same. | 11 |

**References:**


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


Date Course Coordinator Subject Committee Chairperson

## DSC7 Lab: Practical's on Linear Algebra

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|---|---|
| Course Title: Practical's on Linear Algebra | Course code: 21BSC6C14MAP |
| Total Contact Hours: 56 | Course Credits: 02 |
| Internal Assessment Marks: 25 | Duration of SEE: 3 hours |
| Semester End Examination Marks: 25 | |

Course Outcomes (CO's):

**At the end of the course, students will be able to:**

1. Learn Free and OpenSource Software (FOSS) tools for computer programming
2. Solve problem on Linear Algebra studied in MATDSCT 6.1 by using FOSS software's.
3. Acquire knowledge of applications of Linear Algebra through FOSS.

## DSC7 Lab: Practical's on Linear Algebra

| Unit | Description | Hours |
|---|---|---|
| **1** | **Programs using Scilab/Maxima/Python:**<br>**Suggested Programs:**<br>1. Program on linear combination of vectors.<br>2. Program to verify linear dependence and independence.<br>3. Program to find basis and dimension of the subspaces.<br>4. Program to verify if a function is linear transformation or not.<br>5. Program to find the matrix of linear transformation.<br>6. Program to find the Eigenvalues and Eigenvectors of a given linear transformation.<br>7. Program on Rank – nullity theorem.<br>8. Program to verify if the given linear transformation is singular/non-singular.<br>9. Program to find the minimal polynomial of given transformation.<br>10. Program to find the algebraic multiplicity of the Eigenvalues of the given linear transformation.<br>11. Program on diagonalization.<br>12. Program on diagonalization. | 56 |

**References:**


1. I. N. Herstein, Topics in Algebra, 2nd Edition, Wiley.
2. Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2003), Linear Algebra (4th Edition), Printice-Hall of India Pvt. Ltd.
3. F. M. Stewart, Introduction to Linear Algebra, Dover Publications.
4. S. Kumaresan, Linear Algebra, Prentice Hall India Learning Private Limited.
5. Kenneth Hoffman & Ray Kunze (2015), Linear Algebra, (2nd Edition), Prentice Hall India Leaning Private Limited.


Date Course Coordinator Subject Committee Chairperson

## DSC8: Numerical Analysis

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|---|---|
| Course Title: Numerical Analysis | Course code: 21BSC6C15MAL |
| Total Contact Hours: 56 | Course Credits: 04 |
| Internal Assessment Marks: 40 | Duration of SEE: 2 hours |
| Semester End Examination Marks: 60 | |

Course Outcomes (CO's):

**At the end of the course, students will be able to:**

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

1. Describe various operators arising in numerical analysis such as difference operators, shift operators and so on.
2. Articulate the rationale behind various techniques of numerical analysis such as in finding roots, integrals and derivatives.
3. Reproduce the existing algorithms for various tasks as mentioned previously in numerical analysis.
4. Apply the rules of calculus and other areas of mathematics in justifying the techniques of numerical analysis.
5. Solve problems using suitable numerical technique
6. Appreciate the profound applicability of techniques of numerical analysis in solving real life problems and also appreciate the way the techniques are modified to improve the accuracy

**DSC8: Numerical Analysis**

| Unit | Description | Hours |
|---|---|---|
| 1 | **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). | 10 |
| 2 | Solutions to algebraic and transcendental equations - Bisection method, Regula-Falsi method, iterative method Newton-Raphson method and secant method (Plain discussion of the rationale behind techniques and problems on their applications). | 11 |
| 3 | **System of Linear Algebraic Equations** Direct Methods – Gauss elimination method, Gauss-Jordan elimination method and Tringularization method; Iterative methods – Jacobi method, Gauss-Jacobi method, GaussSeidal method, Successive-Over Relaxation method (SOR) method | 11 |
| 4 | **Polynomial Interpolations** Finite differences. Forward, backward and central differences and shift operators: definitions, properties and problems; Polynomial interpolation - | 12 |

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|---|---|---|
| | Newton-Gregory forward and backward interpolation formulas, Gauss's Forward and backward interpolation formulas, Lagrange interpolation polynomial, Newton's divided differences and Newton's general interpolation formula (Discussion on setting up the polynomials, differences between them and problems on their applications). | |
| **5** | **Numerical Differentiation an Integration**<br>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 1/3 rule, Simpson's 3/8 rule and Weddell's rule (derivations for only general quadrature formula, trapezoidal rule and Simpson's 1/3rd rule and problems on the applications of all formulas). | 12 |

**References:**


1. E. Isaacson and H. B. Keller, Analysis of Numerical methods, Dover Publications.
2. S. S. Sastry, Introductory methods of Numerical Analysis, 5th Edition, 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, 4th Edition, 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.


Date Course Coordinator Subject Committee Chairperson

**DSC8 Lab: Practical's on Numerical Analysis**

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|---|---|
| Course Title: Practical's on Numerical Analysis | Course code: 21BSC6C16MAP |
| Total Contact Hours: 56 | Course Credits: 02 |
| Internal Assessment Marks: 25 | Duration of SEE: 3 hours |
| Semester End Examination Marks: 25 | |

Course Outcomes (CO's):

**At the end of the course, students will be able to:**This course will enable the students to

1. Learn Free and Open Source Software (FOSS) tools for computer programming
2. Solve problem on numerical Analysis studied in MATDSCT 6.2 by using FOSS software's.
3. Acquire knowledge of applications of Numerical Analysis through FOSS

**DSC8 Lab: Practical's on Numerical Analysis**

| Unit | Description | Hours |
|---|---|---|
| 1 | **Practical/Lab Work to be performed in Computer Lab (FOSS) Suggested Software:** Maxima/Scilab /Python/R.<br><br>**Suggested Programs:**<br>1. Program to find root of an equation using bisection and Regula-Falsi methods.<br>2. Program to find root of an equation using Newton-Raphson and Secant methods.<br>3. Program to solve system of algebraic equations using Gauss-elimination method.<br>4. Program to solve system of algebraic equations using Gauss-Jordan method.<br>5. Program to solve system of algebraic equation using Gauss-Jacobi method.<br>6. Program to solve system of algebraic equation using Gauss-Seidel method.<br>7. Program to solve the system of algebraic equations using SOR method<br>8. Program to evaluate integral using Simpson's 1/3 and 3/8 rules.<br>9. Program to evaluate integral using Trapezoidal and Weddle rules<br>10. Program to find the sums of powers of successive natural numbers using Newton – Gregory technique.<br>11. Program to find differentiation at specified point using Newton-Gregory interpolation method.<br>12. Program to find the missing value of table using Lagrange method. | 56 |

**References:**


1. E. Isaacson and H. B. Keller, Analysis of Numerical methods, Dover Publications.
2. S. S. Sastry, Introductory methods of Numerical Analysis, 5th Edition, 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.


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