

SRI VENKATESWARA UNIVERSITY - TIRUPATI
B.Sc., (Honours) in MATHEMATICS (MAJOR)
V SEMESTER
(W.E.F. Academic Year 2025 - 26)

COURSE 12: LINEAR ALGEBRA

Theory

Credits: 4

5 hrs. / week

Course Outcomes

After successful completion of this course, the student's will be able to

1. Understand the concepts of vector spaces, subspaces.
2. Understand the concepts of basis, dimension and their properties.
3. Understand the concept of linear transformation and its properties.
4. Apply Cayley- Hamilton theorem to problems for finding the inverse of a matrix and higher powers of matrices without using routine methods.
5. Learn the properties of inner product spaces and determine orthogonality in inner product spaces.

Course Content

UNIT – I

Vector Spaces-I

Vector Spaces - General properties of vector spaces - n-dimensional Vectors - addition and scalar multiplication of Vectors - internal and external composition - Null space - Vector subspaces - Algebra of subspaces - Linear Sum of two subspaces - linear combination of Vectors- Linear span Linear independence and Linear dependence of Vectors.

UNIT –II

Vector Spaces-II

Basis of Vector space - Finite dimensional Vector spaces - basis extension - coordinates- Dimension of a Vector space - Dimension of a subspace - Quotient space and Dimension of Quotient space.

UNIT –III

Linear Transformations

Linear transformations - linear operators- Properties of L. T- sum and product of L. Ts - Algebra of Linear Operators - Range and null space of linear transformation - Rank and Nullity of linear transformations - Rank- Nullity Theorem.

UNIT –IV

Matrices

Characteristic equation - Characteristic Values - Characteristic vectors of a square matrix - Cayley Hamilton Theorem – problems on Cayley Hamilton Theorem.

UNIT –V

Inner product space

Inner product spaces- Euclidean and unitary spaces- Norm or length of a Vector- Schwartz inequality- Triangle Inequality- Parallelogram law- Orthogonality- Orthonormal set - Bessel's inequality.

Activities:

Seminar / Quiz / Assignments / Applications of Linear Algebra in real life problems / Problem Solving.

Text Books

1. Linear Algebra by J.N. Sharma and A.R. Vasishtha, published by Krishna Prakashan Media (P) Ltd.
2. Matrices by A.R. Vasishtha and A.K. Vasishtha, published by Krishna Prakashan Media (P) Ltd.

Reference Books

1. Linear Algebra by Stephen H. Friedberg et. al. published by Prentice Hall of India Pvt. Ltd. 4th Edition, 2007.
2. Linear Algebra by Kenneth Hoffman and Ray Kunze, published by Pearson education , New Delhi.
3. Matrices by Shanti Narayana, published by S. Chand Publications.

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B.Sc., (Honours) in MATHEMATICS (MAJOR)

V SEMESTER

(W.E.F. Academic Year 2025 - 26)

COURSE 13: VECTOR CALCULUS

Theory

Credits: 4

5 hrs. / week

Course Outcomes

After successful completion of this course, the student's will be able to

1. Learn multiple integrals as a natural extension of definite integral to a function of two variables in the case of double integral/three variables in the case of triple integral.
2. Learn applications in terms of finding surface area by double integral and volume by triple integral.
3. Determine the gradient, divergence and curl of a vector and vector identities.
4. Evaluate line, surface and volume integrals.
5. Understand relation between surface and volume integrals (Gauss divergence theorem), relation between line integral and volume integral (Green's theorem), relation between line and surface integral (Stokes theorem)

Course Content

Unit – I

Multiple integrals I

Introduction – Double integrals – Evaluation of double integrals – Properties of double integrals – Region of integration – Double integration in polar coordinates – Change of variables in double integrals – change of order of integration.

Unit–2

Multiple integrals II

Triple integral – region of integration – change of variables – Plane areas by double integrals - surface area by double integral – Volume as a triple integral.

Unit–3

Vector differentiation

Vector differentiation –ordinary – derivatives of vectors – Differentiability –Gradient –Divergence – Curl operators – Vector Identities.

Unit–4

Vector integration

Line Integrals with examples - Surface Integral with examples – Volume integral with examples.

Unit–5

Vector integration applications

Gauss theorem and applications of Gauss theorem - Green's theorem in a plane and applications of Green's theorem - Stokes's theorem and applications of Stokes theorem.

Activities

Seminar / Quiz / Assignments / Applications of Vector calculus to Real life Problems / Problem Solving Sessions.

Text Book

A text Book of Higher Engineering Mathematics by B.S. Grewal, Khanna Publishers, 43rd Edition

Reference Books

1. Vector Calculus by P.C. Matthews, Springer Verlag publications.
2. Vector Analysis by Murray Spiegel, Schaum Publishing Company, New York

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COURSE 14: FUNCTIONS OF A COMPLEX VARIABLE

Theory

Credits: 4

5 hrs. / week

Course Outcomes

After successful completion of this course, the student will be able to

1. Determine a Bilinear transformation under given condition
2. Know about continuity, compactness and connectedness of sets in complex plane
3. Know the necessary condition and sufficient condition for $f(z)$ to be analytic
4. Know about the inverse of an analytic function
5. Know about the convergence of sequences and the necessary & sufficient condition for a sequence to be convergent
6. Know the power series expansion of elementary functions

Course Content

Unit – 1

Bilinear Transformations

Extended Complex Plane – Resultant and Inverse of a bilinear transformation – The linear group – Geometrical significance of the transformation. Angle preserving property of Bilinear Transformation– Determination of Bilinear transformations under given condition, some special bilinear transformations.

Unit – 2

Topological Considerations

Neighbourhood of a point – Interior, exterior and frontier points of a set, open and closed sets. Connected sets, Domains and continua - a theorem on Nests of closed rectangular domains- Bolzano Weierstrass theorem- Hein-Borel theorem. Limits - algebraic operations with limits – continuity and uniform continuity – compactness – connectedness.

Unit – 3

Analytic functions

Differentiable functions of a complex variable - Geometrical representation of a variable - Analytic function- Elementary rules and chain rule - Derivatives of polynomials and rational functions - The necessary condition and sufficient condition for $f(z)$ to be analytic - Analytic functions in a Domain – Derivative of w in polar form - Construction of $f(z)$.

Unit – 4

Inverse of an analytic function and infinite series

The inverse of an analytic function – neighbourhood preserving mappings - Domain preserving and angle preserving property of analytic mappings.

Convergent sequences, necessary and sufficient condition for a sequence to be convergent, Cauchy sequence, Convergence of infinite series. Cauchy general principle of convergence for a series. Absolute convergence of a series.

Unit – 5

Power Series

Power series - exponential, trigonometric and hyperbolic functions - zeros of $\sin z$, $\cos z$ - periods of $\sin z$, $\cos z$, $E(z)$ - A law of logarithms - Analytic character of $\log z$ - Analytic character of z^n - $\cos^{-1} z$, $\sin^{-1} z$ and derivatives of $\cos^{-1} z$, $\sin^{-1} z$.

Activities

Seminar/ Quiz/ Assignments/ Applications of Functions of complex variables to Real life Problem / Problem Solving Sessions.

Text Book

Theory of Functions of a Complex variable by Shanti Narayan & Dr. P. K. Mittal, S. Chand & Company Ltd.

Reference Books

1. Theory of Functions of a Complex Variable by A. I. Markushevich, Second Edition, AMS Chelsea Publishing
2. Theory And Applications by M. S. Kasara, Complex Variables, 2nd Edition, Prentice Hall India Learning Private Limited

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COURSE 14: ADVANCED NUMERICAL METHODS

Theory

Credits: 4

5 hrs. /week

Course Outcomes

After successful completion of this course, the student will be able to

1. Find derivatives using various difference formulae
2. Understand the process of Numerical Integration
3. Solve Simultaneous Linear systems of Equations
4. Understand Iterative methods
5. Find Numerical Solution of Ordinary Differential Equations

Course Content

UNIT – I

Numerical Differentiation

Derivatives using Newton's forward difference formula - Newton's backward difference formula- Derivatives using central difference formula - Stirling's interpolation formula - Newton's divided difference formula.

UNIT – II

Numerical Integration

General quadrature formula on errors - Trapezoidal rule – Simpson's 1/3 rule - Simpson's 3/8 rule- Weddle's rule - Euler-Maclaurin formula of summation and quadrature - The Euler transformation.

UNIT – III

Solution of Simultaneous Linear systems of Equations – I

Solution of linear systems - Direct Methods - Matrix inversion method – Gaussian elimination method- Gauss Jordan Method.

UNIT – IV

Solution of Simultaneous Linear systems of Equations – II

Method of factorization - solution of Tridiagonal systems - Iterative methods - Jacobi's method - Gauss - Seidel method.

UNIT – V

Numerical Solution of Ordinary Differential Equations

Introduction – solution of Taylor's series – Picard's method of successive approximations – Euler's method – Modified Euler's method – Runge - Kutta methods.

Activities

Seminar / Quiz / Assignments / Applications of Numerical methods to Real life Problem
/ Problem Solving Sessions.

Text Book

Numerical Analysis by G. Shanker Rao, New Age International Publications

Reference Books

1. Applied Numerical Analysis by Curtis F. Gerald and Patrick O. Wheatley, Pearson Publications.
2. Numerical Methods for Scientific and Engineering Computation by M. K. Jain, S. R. K. Iyengar and R. K. Jain, New Age International Publishers.

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COURSE 15: NUMBER THEORY

Theory

Credits: 4

5 hrs. / week

Learning Outcomes

After successful completion of the course, students will be able to

1. Understand the fundamental theorem of arithmetic
2. Understand Mobius function, Euler quotient function, The Mangoldt function, Liouville's function, The divisor functions and the generalized convolutions.
3. Understand Euler's summation formula, application to the distribution of lattice points and the applications to $\mu(n)$ and $\Lambda(n)$
4. Understand the concepts of congruences, residue classes and complete residues systems.
5. Comprehend the concept of quadratic residues mod p and quadratic non residues mod p .

UNIT-I

The Fundamental Theorem of Arithmetic

Introduction, Divisibility, Greatest common divisor, Prime numbers, The fundamental theorem of arithmetic, The series of reciprocals of the primes, The Euclidean algorithm, The greatest common divisor of more than two numbers

UNIT-II

Arithmetical Functions and Dirichlet Multiplication

Introduction- The Mobius function $\mu(n)$ – The Euler quotient function $\varphi(n)$ - A relation connecting φ and μ - A product formula for $\varphi(n)$ - The Dirichlet product of arithmetical functions- Dirichlet inverses and the Mobius inversion formula- The Mangoldt function $\Lambda(n)$ - multiplicative functions- multiplicative functions and Dirichlet multiplication- The inverse of a completely multiplicative function-Liouville's function $\lambda(n)$ - The divisor functions $\sigma_\alpha(n)$

UNIT-III

Averages Of Arithmetical Functions

Introduction- The big oh notation. Asymptotic equality of functions- Euler's summation formula- Some elementary asymptotic formulas-The average order of $d(n)$ - The average order of the divisor functions $\sigma_\alpha(n)$ - The average order of $\varphi(n)$ - An application to the distribution of lattice points visible from the origin- The average order of $\mu(n)$ and $\Lambda(n)$ -The partial sums of a Dirichlet product- Applications to $\mu(n)$ and $\Lambda(n)$

UNIT-IV

Congruences

Definition and basic properties of congruences- Residue classes and complete residue systems- Linear congruences- Reduced residue systems and the Euler- Fermat theorem- Polynomial congruences modulo p . Lagrange's theorem- Applications of Lagrange's theorem- Simultaneous linear congruences. The Chinese remainder theorem- Applications of the Chinese remainder theorem.

UNIT-V

Quadratic Residues and the Quadratic Reciprocity Law

Quadratic Residues, Legendre's symbol and its properties, Evaluation of $(-1/p)$ and $(2/p)$, Gauss lemma, The Quadratic reciprocity law, Applications of the reciprocity law, The Jacobi Symbol, Gauss sums and the quadratic reciprocity law, the reciprocity law for quadratic Gauss sums, Another proof of the quadratic reciprocity law.

Activities

Seminar / Quiz / Assignments / Applications of Number theory to Real life Problem / Problem Solving Sessions

Text Book

Introduction to Analytic Number Theory by T.M. Apostol, Springer Verlag-New York, Heidelberg- Berlin-1976.

Reference Books

1. Elementary Number Theory by G.A. Jones and J.M. Jones, , Springer
2. Elementary Number Theory by David M. Burton, 2nd Edition UBS Publishers.
3. Number Theory by Hardy & Wright, Oxford Univ., Press.
4. Elements of the Theory of Numbers by Dence, J. B &Dence T.P, Academic Press

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COURSE 15: MATHEMATICAL STATISTICS

Theory

Credits: 4

5 hrs. / week

Course Outcomes

After completion of the course, student will be able to

1. Understand the probability set function and conditional probability
2. Understand about random variables, discrete and continuous type distributions
3. Understand the distribution of two random variables and expectation of a random variables
4. Know binomial and related distributions
5. Normal distributions and the applications of normal distributions

Unit – 1

Probability and Distributions

Sets – set functions – The probability set function – counting rules – additional properties of probability- conditional probability and independence - simulations

Unit – 2

Probability and Distributions continued...

Random Variables - Discrete Random Variables - Continuous Random Variables -Quantiles- Transformations - Mixtures of Discrete and Continuous Type Distributions Expectation of a Random Variable - Computation for an Estimation of the Expected Gain.

Unit – 3

Multivariate Distributions

Distributions of Two Random Variables - Marginal Distributions - Expectation –Transformations Bivariate Random Variables - Conditional Distributions and Expectations - Independent Random Variables - The Correlation Coefficient - Extension to Several Random Variables – Multivariate Variance-Covariance Matrix- Transformations for Several Random Variables - Linear combinations of Random Variables.

Unit – 4

Some Special Distributions

The Binomial and Related Distributions - Negative Binomial and Geometric Distributions - multinomial Distribution- Hypergeometric Distribution - The Poisson Distribution.

Unit – 5

Normal Distribution

The Normal Distribution - Contaminated Normals - The Multivariate Normal Distribution - Bivariate Normal Distribution - Multivariate - Normal Distribution.

Activities

Seminar / Quiz / Assignments / Applications of Mathematical statistics to Real life Problem / Problem Solving Sessions.

Text Book

Introduction to Mathematical Statistics by Robert V Hogg, Joseph W MacKeen, Eighth Edition, Allen T Craig, Pearson

Reference Books

1. Fundamentals of Statistics by Goon A.M., Gupta M.K. and Dasgupta B., (2002) Vol. I & II, 8th Edn. The World Press, Kolkata.
2. Fundamentals Of Mathematical Statistics by Gupta, S. C. and Kapoor, V.K. (2008): 4th Edition (Reprint), Sultan Chand & Sons
3. Mathematical Statistics with Applications by Miller, Irwin and Miller, Marylees (2006) John E. Freund's, (7th Edn.), Pearson Education, Asia.
4. Introduction to the Theory of Statistics by Mood, A.M. Graybill, F.A. and Boes, D.C., (2007), 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co.Ltd.

S.V.UNIVERSITY, MODEL PAPER

V SEMESTER

Subject: MATHEMATICS

Paper: LINEAR ALGEBRA

Time: 3 hours

Max Marks: 75

SECTION – A

Answer any FIVE of the following questions.

Each question carries 5 marks

(5X5 = 25).

1. Show that the set $W = \{ (x - y, y - z, 0) : x, y, z \in \mathbb{R} \}$ is a subspace of $\mathbb{R}^3$.
2. Verify that the polynomials $1 + 2t^2$, $4 + t + 5t^2$ and $3 + 2t$ are linearly independent in P_2 .
3. Find the basis and the dimension of the subspace $H = \{ (s - 2t, s + t, 3t) : s, t \in \mathbb{R} \}$ of the vector space $\mathbb{R}^3$.
4. Let $T: \mathbb{R}^2 \rightarrow \mathbb{R}^2$ be a linear transform with $T(e_1) = (3, 1, 3, 1)$ and $T(e_2) = (-5, 2, 0, 0)$, where $e_1 = (1, 0)$ and $e_2 = (0, 1)$. Then find T
5. Let $T: V \rightarrow W$ be a linear transformation. Then prove that Range of T is a subspace of W.
6. Find the rank of the matrix $A = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}$.
7. Find the eigen value of the matrix $A = \begin{pmatrix} 7 & 0 & 0 \\ 8 & -4 & 0 \\ 1 & 5 & 2 \end{pmatrix}$.
8. State and prove parallelogram law in Inner product space.

SECTION – B

Answer ALL of the following questions. (5X10 =50).

9. a) Prove that the set of the polynomials with real coefficients of degree at most n is a vector space over real numbers.

OR

- b) Let W be a non-empty subset of a vector space $V(F)$. Then prove that W is a subspace of V if $a\alpha + b\beta \in W \forall a, b \in F$ and $\alpha, \beta \in W$.
- 10.a) Let $V(F)$ be a finite dimensional vector space of dimension n and W be a subspace of V . Then prove that W is a finite dimensional and $\dim W \leq n$.

OR

- b) Let W_1 and W_2 be two subspace of vector space R^4 given by
 $W_1 = \{(a, b, c, d) : b - 2c + d = 0\}$ and
 $W_2 = \{(a, b, c, d) : a = d, b = 2c\}$. Then find $\dim(W_1 + W_2)$.
11. a) State and prove Rank – Nullity theorem.

OR

- b) Find the range and null space of a linear operator on R^3 defined by $T(a, b, c) = (3a, a - b, 2a + b + c)$.
12. a) State and prove Caley-Hamilton theorem.

OR

- b) Prove that the eigen vectors of a distinct eigen values are linearly independent.
13. a) State and prove Schwartz Inequality.

OR

- b) State and prove Bessel's Inequality.

S.V.UNIVERSITY,

MODEL PAPER

V SEMESTER

Subject : MATHEMATICS

Paper : VECTOR CALCULUS

Time: 3 hours

Max Marks:75

SECTION - A

Answer any FIVE of the following questions. Each question carries 5 marks (5X5 = 25).

1) Evaluate $\int_0^4 \int_0^{x^2} e^{y/x} dx dy$.

2) Evaluate $\int_{-1}^1 \int_0^z \int_{x-z}^{x+z} (x + y + z) dz dx dy$.

3) Evaluate $\iiint xyz dx dy dz$ over the positive octant of the sphere $x^2 + y^2 + z^2 = a^2$ by transforming into spherical co-ordinates.

4) Find the angle between the surfaces $x^2 + y^2 + z^2 = 9$, $x^2 + y^2 + z = 3$ at $(2, -1, 2)$.

5) If $\vec{F} = 3xy\vec{i} - y^2\vec{j}$ Evaluate $\int_C \vec{F} \cdot d\vec{r}$ where C is the curve $y = 2x^2$ in the xy-plane.

6) Evaluate $\oint_C \vec{F} \cdot d\vec{r}$, where 'C' is circle $x^2 + y^2 = 1, z = 0$ and $\vec{F} = y\vec{i} + z\vec{j} + x\vec{k}$.

7) Verify green's theorem in the plane $\oint_C (x + y + y^2) dx + x^2 dy$. Where 'C' is closed curve of the region bounded by $y = x$, & $y = x^2$.

8) Show that $\text{grad } r^m = m r^{m-2} \cdot \vec{r}$

SECTION - B

Answer ALL of the following questions. Each question carries 10 marks (5X10 =50).

9 a) Evaluate $\int_0^a \int_0^{\sqrt{a^2-x^2}} \sqrt{a^2-x^2-y^2} \, dx dy$.

OR

b) Evaluate $\iint (x+y)^2 \, dx dy$ over the area bounded by the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$.

10 a) Using double integral find area enclosed by the curves $y=2x^2$ & $y^2=4x$.

OR

b) Find the area of the surface of the sphere $x^2+y^2+z^2=9a^2$ cutoff by the cylinder

$$x^2+y^2=3ax.$$

11 a) If $\vec{r} = a \cos t \vec{i} + a \sin t \vec{j} + at \tan \theta \vec{k}$ then find $\left| \frac{d\vec{r}}{dt} \times \frac{d^2\vec{r}}{dt^2} \right|$ and $\left[\frac{d\vec{r}}{dt} \cdot \frac{d^2\vec{r}}{dt^2} \cdot \frac{d^3\vec{r}}{dt^3} \right]$.

OR

b) If $\vec{F} = \text{grad} (x^3+y^3+z^3 - 3xyz)$ then find $\text{div} \vec{F}$ and $\text{curl} \vec{F}$.

12 a) Evaluate $\int_S \vec{F} \cdot \vec{N} \, ds$, $\vec{F} = z\vec{i} + x\vec{j} - 3y^2z\vec{k}$ and 'S' is the surface $x^2+y^2=16$ included in first

Octant between $z=0$ & $z=5$.

OR

b) If $\vec{F} = 2xz\vec{i} - x\vec{j} + y^2\vec{k}$ evaluate $\int F dv$ where $\overline{v}$ is the region bounded by the surface $x=0$,

$$x=2, y=0, y=6, z=x^2, z=4.$$

13 a) State and prove Gauss's divergence theorem.

OR

b) State and prove Stoke's theorem.

MODEL QUESTION PAPER

V SEMESTER

NUMBER THEORY

Time: 3 Hours

Max.Marks:75

PART A

Answer any FIVE of the following Question:

5 X 5=25M

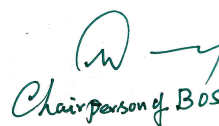
1. The product of any three Consecutive integers is divisible by 3!
2. Let **a** and **b** be positive integer such that $a \geq b$ and Let $r_n = 0$ Euclid's algorithms then r_{n-1} gcd of a and b
3. Use Fermats methods to factor 10541
4. If p is a Prime then Prove that $(p-1)! \equiv -1 \pmod{p}$
5. Show that the linear Congruence $6x \equiv 15 \pmod{21}$
6. Define Euler's Phi(Φ), Tau(τ) and Sigma(σ) functions with Example
7. If $m, n > z$ and $(m, n) = 1$ then there exists no primitive roots $\pmod{mn}$
8. Find the index of 5 $\pmod{13}$

PART B

Answer any FIVE of the following Question:

5 X 10=50M

9. (a) State and Prove Fundamental theorem of arithmetic
Or
(b) If a and b are any two integers not both zero then gcd(a,b) exists and its unique
10. (a) State and Prove Chinese remainder theorem
Or
(b) State and Prove Mobius inversion formulae
11. (a) Factorize 493 by Euler's factorization method
Or
(b) Find the remainder when 41^{65} is divided by 7
12. (a) solve $81x + 6y = 29$
Or
(b) If a/c and b/c with gcd(a,b)=1 then Prove that ab/c
13. (a) For any integer **a**, Prove that $a^4 \equiv 0$ or $1 \pmod{5}$
Or
(b) State and Prove Euler's theorem


Chairperson of BOS