ANDHRA KESARI UNIVERSITY:: ONGOLE

Model Syllabus for 4-Year UG Honours in B.Sc. (Mathematics) as Major in consonance with Curriculum framework w.e.f. AY 2025-26

COURSE STRUCTURE (for Semester I to VI)

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
I	I	1	Differential Equations	4	5
		2	Solid Geometry	4	5
	II	3	Group Theory	4	5
		4	Elementary Real Analysis	4	5
II	III	5	Ring Theory	4	5
		6	Advanced Real Analysis	4	5
		7	Theory of Matrices	4	5
	IV	8	Linear algebra	4	5
		9	Vector Calculus	4	5
		10	Linear Programming Program	4	5
III	V	11	Special Functions	4	5
		12 A	Laplace Transforms	4	5
			OR		
		12 B	Foundations of Automata Theory	4	5
		13 A	Numerical Methods	4	5
			OR		
		13 B	Mathematical Methods using MatLab	4	5

SEMESTER-III

COURSE 5: RING THEORY

Theory	Credits: 4	5 hrs/week

Course Objectives

1. The course aims to:
2. Introduce the fundamental concepts and properties of rings, fields, and integral domains.
3. Explain the structure and significance of subrings and ideals, including prime and maximal ideals.
4. Construct quotient rings and develop composition tables for finite rings.
5. Explore ring homomorphisms, isomorphisms, and apply the fundamental theorems of ring homomorphisms.
6. Study polynomial rings, including operations, division algorithm, irreducibility, and ideal structures.

Course Outcomes

1. Upon successful completion of this course, students will be able to:
2. Understand and differentiate between rings, integral domains, and fields, and describe their algebraic properties.
3. Identify and construct subrings and various types of ideals, and determine when a ring qualifies as a field.
4. Analyze quotient rings, build composition tables for finite rings, and distinguish between prime and maximal ideals.
5. Apply ring homomorphisms and isomorphisms effectively, and interpret the fundamental homomorphism theorems.
6. Solve problems involving polynomial rings over fields, including division algorithms, factorization, and irreducibility criteria.

Course Content

Unit – 1

Definition of a Ring and Examples –Basic properties – Commutative ring - Boolean ring – Zero Divisors of a ring - Cancellation Laws – Integral Domain – Division ring – Field - Idempotent and nilpotent elements in a ring and integral domain.

Unit – 2

The Characteristic of a Ring - The characteristics of integral domain, filed, Boolean ring - Definition and examples of Subrings – Necessary and sufficient condition for a nonempty subset to be a subring – Algebra of Subrings – Centre of a ring – Ideals – Algebra of ideals – A commutative ring with unity and without proper ideals is a filed.

Unit – 3

Principal ideal – Principal ideal ring: definition and theorems Cosets in ring structure - Quotient ring : definition, examples and theorems– Euclidean rings : definition, examples and theorems.

Unit – 4

Homomorphism of Rings – Definition and Elementary properties – Kernel of a homomorphism – Isomorphism – Fundamental theorem of homomorphism of rings – Maximal and prime Ideals.

Unit – 5

Polynomials over a ring – Algebra of polynomials –Degree of a polynomial and related problems -- The Division Algorithm in $F[x]$ – Remainder and Factor Theorems– Irreducible Polynomials – Ideal structure in F[x] – Uniqueness of Factorization in F[x].

Activities

The activities include quizzes, assignments, seminars, and student presentations. Additional tasks involve mini projects, concept flowcharts, operator method charts, peer teaching, LMS-based quizzes, board work challenges, poster presentations, and visual aids like chalk talks to enhance learning and engagement.

Text book

Modern Algebra by A.R.Vasishta and A.K.Vasishta, Krishna Prakashan Media Pvt. Ltd.

Reference books

1. A First Course in Abstract Algebra by John. B. Farleigh, Narosa Publishing House.
2. Linear Algebra by Stephen. H. Friedberg and Others, Pearson Education India

*****

SEMESTER-III

COURSE 6: ADVANCED REAL ANALYSIS

Theory	Credits: 4	5 hrs/week

Course Objectives

This course is designed to:

1. Develop a deep understanding of infinite series with non-negative terms and apply various convergence tests.
2. Introduce the concepts of limits and continuity, including their behavior at finite and infinite points.
3. Explore types of discontinuities and apply fundamental theorems related to continuous functions.
4. Understand differentiability and apply Mean Value Theorems in problem-solving.
5. Introduce Riemann integration and explore key properties and theorems of integrable functions.

Course Outcomes

Upon successful completion of this course, students will be able to:

1. Apply convergence tests such as P-test, Cauchy's root test, D'Alembert's ratio test, and Leibnitz test to analyze series.
2. Understand and evaluate limits of real-valued functions, including one-sided and infinite limits, and solve problems involving indeterminate forms.
3. Demonstrate knowledge of continuity, identify types of discontinuities, and apply theorems like Heine's, Borel's, and Bolzano's in analysis.
4. Understand and analyze differentiability, distinguish it from continuity, and apply Rolle's, Lagrange's, and Cauchy's Mean Value Theorems.
5. Evaluate Riemann integrals, verify conditions for integrability, and apply the Fundamental Theorem of Calculus in integration problems.

Unit – 1

Alternating Series – Leibnitz Test – Absolute and conditional convergence – Theorems and problems relating to them – Dirichlet's test – Abel's test (Problems only)

Unit – 2

Real valued Functions - Boundedness of a function - Monotone functions - Limit of a function - Algebra of limits - Sandwich theorem on limit point – Limits of some standard functions – forms – Infinite limits – Limits at infinity.

Unit – 3

Continuity and discontinuity of a function and examples - Heine's theorem- Modulus of a continuous function is a continuous function - Borel's theorem- Every continuous function is bounded - Every continuous and bounded function defined on [a,b] attains its bounds -Bolzano's theorem - Bolzano's intermediate value theorem – Uniform continuity – Every continuous function on closed interval is uniformly continuous.

Unit – 4

The derivability of a function at a point and on an interval - Derivability and continuity of a function - Darboux's theorem (statement only) - Darboux's intermediate value theorem - Mean value Theorems : Rolle's theorem, Lagrange's theorem, Cauchy's Mean value theorem – Problems

Unit – 5

Riemann Integration – Upper and lower Riemann sums, and integrals - Riemann integrable functions - Necessary and sufficient condition for integrability – Continuous function on closed interval is integrable - Monotonic function on closed interval is integrable - Properties of integrable functions - Fundamental theorem of integral calculus – Problems

Activities

The activities include quizzes, assignments, seminars, and student presentations. Additional tasks involve mini projects, concept flowcharts, operator method charts, peer teaching, LMS-based quizzes, board work challenges, poster presentations, and visual aids like chalk talks to enhance learning and engagement.

Text Book

An Introduction to Real Analysis by Robert G.Bartle and Donlad R. Sherbert, John Wiley and sons Pvt. Ltd

Reference Books

1. Elements of Real Analysis by Shanthi Narayan and Dr. M.D. Raisinghania, S. Chand & Company Pvt. Ltd., New Delhi.
2. Principles of Mathematical Analysis by Walter Rudin, McGraw-Hill Ltd.

*****

SEMESTER-III

COURSE 7: THEORY OF MATRICES

Theory	Credits: 4	5 hrs/week

Course Objectives

This course aims to:

1. Develop an understanding of special matrices such as symmetric, Hermitian, orthogonal, and unitary matrices and their properties.
2. Explain the computation and properties of determinants and how they are used in matrix operations.
3. Teach methods to find the rank and inverse of matrices using elementary transformations.
4. Provide techniques to analyze and solve systems of linear equations using matrix methods.
5. Introduce the concepts of eigenvalues and eigenvectors, and highlight their significance in linear algebra and applications.

Course Outcomes

Upon successful completion of this course, students will be able to:

1. Compute the determinant of a matrix using expansion and apply various properties for simplification.
2. Perform elementary row and column operations to simplify determinants and matrix expressions.
3. Determine the rank of a matrix using echelon and normal forms, and compute matrix inverses via transformations.
4. Analyze systems of linear equations (homogeneous and non-homogeneous) for consistency, and solve them using methods such as matrix inversion, Cramer's Rule, Gauss elimination, and LU decomposition.
5. Define and compute eigenvalues and eigenvectors of square matrices, and use characteristic equations in applications.

Course Content

Unit I

Matrix – Algebra of Matrices – Matrix Multiplication – Transpose and trace of a matrix - Symmetric and Skew symmetric matrices - Hermitian and Skew Hermitian matrices - Orthogonal and Unitary matrices - Idempotent matrix - Nilpotent Matrix – Involutory Matix – examples and related problems – Every square matrix can be expressed as a sum of a symmetric and a skew symmetric matrix – countable and uncountable sets - If $AB = A$ and $BA = B$, then A and countable and uncountable sets are idempotent.

Unit – 2

Determinant of a square matrix (of order 3) - Minors and Cofactors - Properties of determinants - Product of two determinants of the same order - Adjoint and Inverse of a matrix – Orthogonal matrix - Problems

Unit -3

Rank of a matrix - Elementary row and column operations on a matrix – Properties of elementary matrices – Reduction to Echelon form and Normal form - Inverse of a non-singular matrix by elementary transformations – Related problems – The rank of product of matrices cannot exceed the rank of either.

Unit -4

System of homogeneous linear equations – Conditions for trivial and non-trivial solutions – Solving methods of homogeneous linear equations system - System of non-homogeneous linear equations – Conditions for consistency and inconsistency – Matrix Inversion method – Cramer's Rule – Gauss method- LU decomposition method.

Unit - 5

Characteristic (Eigen) Values and Characteristic vectors of a square matrix - Characteristic polynomial and Characteristic equation of a matrix – Finding eigenvalues and eigen vectors of a square matrix.

Activities

The activities include quizzes, assignments, seminars, and student presentations. Additional tasks involve mini projects, concept flowcharts, operator method charts, peer teaching, LMS-based quizzes, board work challenges, poster presentations, and visual aids like chalk talks to enhance learning and engagement.

Text book

Matrices , by A.R.Vasishtha and A.K.Vasishtha, published by Krishna Prakashan Media (P) Ltd.

Reference books

1. S. H. Friedberg, A.L.Insel and L.E.Spence, Linear Algebra, Prentice Hall of India (P) Ltd, New Delhi, 2004.
2. R D Sharma and Umash Kumar Basic Applied Mathematics for physical sciences, pearson Education India (P) Ltd
3. Richard Bronson, Theory and problems of Matrix operations, Tata Mc Graw Hill 1989.

****

SEMESTER-IV

COURSE 8: LINEAR ALGEBRA

Theory	Credits: 4	5 hrs/week

Course Objectives

1. To introduce the fundamental concepts of vector spaces, subspaces, and their algebraic structure.
2. To develop an understanding of basis and dimension of vector spaces and their associated theorems.
3. To explore linear transformations and their properties, including rank, nullity, and the Rank-Nullity Theorem.
4. To apply the Cayley-Hamilton Theorem to compute powers and inverses of matrices without using direct methods.
5. To understand the structure of inner product spaces and study orthogonality and related geometric properties.

Course Outcomes

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

1. Understand and apply the definitions and properties of vector spaces, subspaces, linear combinations, and linear span.
2. Determine the basis and dimension of vector spaces and subspaces, and apply related theorems including those on quotient spaces.
3. Define linear transformations and operators, compute rank and nullity, and apply the Rank-Nullity Theorem.
4. Use the Cayley-Hamilton Theorem to verify matrix equations and to compute matrix inverses and higher powers.
5. Understand inner product spaces, verify orthogonality, and apply key inequalities such as Schwarz's and Triangle inequalities.

Course Content

Unit –1

Vector Spaces - General properties of vector spaces - n-dimensional Vectors - Addition and scalar multiplication of Vectors - Vector subspaces -Algebra of subspaces - Linear Sum of two subspaces - linear combination of Vectors- Linear Span - Linear independence and Linear dependence of Vectors.

Unit-2

Basis of a Vector space –Problems on basis of a vector space - Finite Dimensional Vector spaces - Basis existence theorem – Extension and uniqueness theorems and problems on them -Dimension of a Vector space - Dimension of a subspace - Quotient space and Dimension of Quotient space – Theorems on dimensions

Unit –3

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 transformation - Rank- Nullity Theorem.

Unit –4

Cayley Hamilton Theorem – Verification Problems – Finding inverse using Cayley Hamilton Theorem - Inner product spaces- Euclidean and Unitary spaces- Norm or length of a Vector - Problems

Unit –5

Schwartz inequality- Triangle Inequality- Parallelogram law- Orthogonal and Orthonormal sets and problems on them – Gram Schmidt orthogonalization Process(Only problems).

Activities

The activities include quizzes, assignments, seminars, and student presentations. Additional tasks involve mini projects, concept flowcharts, operator method charts, peer teaching, LMS-based quizzes, board work challenges, poster presentations, and visual aids like chalk talks to enhance learning and engagement.

Text Book

Linear Algebra by J.N. Sharma and A.R. 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 low priced edition), New Delhi.
3. Matrices by Shanti Narayana, published by S. Chand Publications

*****

SEMESTER-IV

COURSE 9: VECTOR CALCULUS

Theory	Credits: 4	5 hrs/week

Course Objectives

1. To introduce the concept of vector differentiation and the use of vector operators such as gradient, divergence, and curl.
2. To extend the concept of definite integrals to functions of multiple variables through double and triple integrals.
3. To apply double and triple integrals in evaluating areas and volumes in different coordinate systems.
4. To provide knowledge on evaluating line, surface, and volume integrals using vector calculus techniques.
5. To understand and apply major vector integration theorems like Gauss's Divergence Theorem, Green's Theorem, and Stokes's Theorem.

Course Outcomes

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

1. Understand and compute vector derivatives, including gradient, divergence, and curl, and apply vector identities in problem-solving.
2. Evaluate double integrals over various regions and use polar coordinates when appropriate.
3. Compute triple integrals in Cartesian and polar coordinates, and apply them to find volumes of solids.
4. Evaluate line, surface, and volume integrals using the appropriate vector calculus methods and geometric interpretations.
5. Apply Gauss's, Green's, and Stokes's theorems to relate different types of integrals and solve physical and geometrical problems

Course Content

Unit – 1

Vector differentiation – ordinary derivatives of vectors – Differentiability – Gradient –Divergence - Curl operators - Relations involving the operators - Problems

Unit – 2

Introduction to double integrals - Evaluation of double integrals – Properties of double integrals - Region of integration - double integration in Polar Co-ordinates – Jacobian and change of variables.

Unit – 3

Triple integral - Region of integration - Change of variables – Evaluation of triple integrals both in Cartesian and polar coordinates – Jacobian and change of variables.

Unit – 4

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

Unit – 5

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

Activities

The activities include quizzes, assignments, seminars, and student presentations. Additional tasks involve mini projects, concept flowcharts, operator method charts, peer teaching, LMS-based quizzes, board work challenges, poster presentations, and visual aids like chalk talks to enhance learning and engagement.

Text Book

A text Book of Higher Engineering Mathematics by B.S. Grawal, 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, NewYork

*****

SEMESTER-IV

COURSE 10: LINER PROGRAMMING PROBLEMS

Theory	Credits: 4	5 hrs/week

Course Objectives

1. To introduce the concept of convex sets and the foundational principles of linear programming.
2. To develop the ability to formulate real-life problems into linear programming models.
3. To provide graphical and algebraic techniques for solving linear programming problems.
4. To equip students with the knowledge of the simplex method, artificial variables, and special cases in LPP.
5. To explore issues such as degeneracy, alternative solutions, unboundedness, and infeasibility in linear programming problems.

Course Outcomes

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

1. Understand the structure of convex sets, convex combinations, and apply the fundamental theorem of linear programming to real-world problem formulation.
2. Solve LPPs graphically and represent LP problems in standard, canonical, and matrix forms.
3. Apply the simplex method to solve linear programming problems and interpret unbounded or multiple solutions.
4. Use artificial variable techniques such as the Big M-method and the two-phase method to handle constraints with equality and greater-than conditions.
5. Identify and resolve issues in LPP such as degeneracy, alternative and unbounded solutions, and apply the simplex method to solve systems of simultaneous equations.

Course Content

UNIT-I

Convex Set- Extreme points of a convex set- Convex combination- Convex hull- Convex polyhedron- Fundamental theorem of linear programming - Formulation of linear programming of problems (LPP)

UNIT-2

Graphical solution of linear programming problems- General formulation of LP problems-Standard form and matrix form of LP problems-Standard from and Canonical form of LP Problems

UNIT-3

Introduction of Simplex method - Definitions and notations - Computational procedure of simplex algorithm- Simple way for simplex computations – Unbounded and Alternative solutions

UNIT -4

Artificial variables- Big M-Method and its applications and Two-phase method- Alternative method of two-phase simplex method

UNIT - 5

Degeneracy in LPP and method to resolve degeneracy- Alternative solutions- Unbounded solutions- Non-existing feasible solutions- Solution of simultaneous equations by Simplex method.

Activities

The activities include quizzes, assignments, seminars, and student presentations. Additional tasks involve mini projects, concept flowcharts, operator method charts, peer teaching, LMS-based quizzes, board work challenges, poster presentations, and visual aids like chalk talks to enhance learning and engagement.

Text book

Scope as in "Operations Research" by S.D. Sharma, Kedar Nath, Ram Nath & Co- Meerut.

Reference Book

"Operation Research" by Kanthi Swarup- R.K. Gupta and Manmohan- S. Chand publications, New Delhi

****