B.A./B.Sc. III (SEMESTER-V) PAPER-I Group and Ring Theory & Linear Algebra

Programme: Degree Class: B.A./B.Sc.	Year: Third	Semester: Fifth
Subject: Mathematics		
Course Code: B030501T	Course Title: Group and Ring Theory & Linear Algebra	

Course outcomes:

CO1: Liner algebra is a basic course in almost all branches of science. The objective of this course is to introduce a student to the basics of linear algebra and some of its applications.

CO2: Students will be able to know the concepts of group, ring and other related properties which will prepare the students to take up further applications in the relevant fields.

CO3: The student will use this knowledge in computer science, finance mathematics, industrial mathematics and bio mathematics. After completion of this course students appreciate its interdisciplinary nature.

Credits: 5	Core Compulsory / Elective
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0

PART-A

Group and Ring Theory

Unit	Topics	No. of Lectures
I	Automorphism, inner automorphism, Automorphism groups, Automorphism groups of finite and infinite cyclic groups,	10
II	Characteristic Subgroups, Commutator subgroup and its properties; Applications of factor groups to automorphism groups, Polynomial rings over commutative rings.	9
III	Polynomial rings over commutative rings, Division algorithm and consequences, Principal ideal domains, Factorization of polynomials, Reducibility tests, Irreducibility tests, Eisenstein Criterion of Irreducibility of polynomials over rational field.	9
IV	Divisibility in integral domains, Irreducibles, Primes, Unique factorization domains, Euclidean domains.	9

PART-B

Linear Algebra

Unit	Topics	No. of Lectures
V	Vector spaces and their elementary properties Subspaces, Linear independence and dependence of vectors, Basis and Dimension, Direct sum, Quotient space.	10
VI	Linear transformations, The Algebra of linear transformations, Range and Null space of a linear Transformation	10
VII	Rank and nullity theorem, their representation as Linear Transformations and matrices, Change of Basis.	9
VIII	Inner product spaces and norms, Cauchy-Schwarz inequality, Orthogonal vectors, Orthonormal sets and bases, Bessel's inequality for finite dimensional spaces, Gram-Schmidt orthogonalization process. **The topic "Indian Ancient Mathematics and Mathematicians" should be covered under Continuous Internal Evaluation (CIE). (Appendix)**	9

Suggested Readings:

1. I. N. Herstein, **Topics in Algebra**. 2006
2. B. Dubey, **Introductory Linear Algebra**, Asian Books Pvt Ltd, 2007
3. K. Hoffman and R. Kunze**, Linear Algebra**. 2015
4. David C Lay**, Linear Algebra**, Pearson 2016
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), BCA, B.Sc. (C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/ Objective Tests	5
3	Presentation	5
4	Assignment (Introduction to Indian ancient Mathematics and Mathematicians)	5

Course prerequisites: To study this course, a student must have Diploma in Mathematics

Suggested equivalent online courses:

Further Suggestions:

B.A./B.Sc. III (SEMESTER-V) PAPER-II (i) Number Theory & Game Theory

Programme: Degree Class: B.A./B.Sc.	Year: Third	Semester: Sixth
Subject: Mathematics		
Course Code: B030502T	Course Title: Number Theory & Game Theory	

Course outcomes:

CO1: Upon successful completion, students will have the knowledge and skills to solve problems in elementary number theory and also apply elementary number theory to cryptography.

CO2: This course provides an introduction to Game Theory. Game Theory is a mathematical framework which makes possible the analysis of the decision-making process of interdependent subjects. It is aimed at explaining and predicting how individuals behave in a specific strategic situation, and therefore help improve decision making.

CO3: A situation is strategic if the outcome of a decision problem depends on the choices of more than one person. Most decision problems in real life are strategic.

CO4: To illustrate the concepts, real-world examples, case studies, and classroom experiments might be used.

Credits: 5	Core Compulsory / Elective
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0

Part- A
Number Theory

Unit	Topics	No. of Lectures
I	**Theory of Numbers** Divisibility; Euclidean algorithm; primes; congruences; Fermat's theorem, Euler's theorem and Wilson's theorem; Fermat's quotients and their elementary consequences; solutions of congruences; Chinese remainder theorem; Euler's phi-function.	10
II	**Congruences** Congruence modulo powers of prime; primitive roots and their existence; quadratic residues; Legendre symbol, Gauss' lemma about Legendre symbol; quadratic reciprocity law; proofs of various formulations; Jacobi symbol.	9
III	**Diophantine Equations** Solutions of $ax + by = c$, $x^n + y^n = z^n$; properties of Pythagorean triples; sums of two, four and five squares; assorted examples of Diophantine equations.	9
IV	**Generating Functions and Recurrence Relations** Generating Function Models, calculating coefficient of generating functions, Partitions, Exponential Generating Functions, A Summation Method. Recurrence Relations: Recurrence Relation Models, Divide and conquer Relations, Solution of Linear, Recurrence Relations, Solution of Inhomogeneous Recurrence Relations, Solutions with Generating Functions.	9

Part- B
Game Theory

Unit	Topics	No. of Lectures
V	Introduction, overview, uses of game theory, some applications and examples, and formal definitions of: the normal form, payoffs, strategies, pure strategy Nash equilibrium.	10
VI	Introduction, characteristic of game theory, Two- person zero-sum game, Pure and Mixed strategies, Saddle point and its existence.	10
VII	Fundamental Theorem of Rectangular games, Concept of Dominance, Dominance and Graphical method of solving rectangular games.	9
VIII	Relationship between rectangular game and Linear Programming Problem, reduction of m x n game and solution of 2x2, 2 x s, and r x 2 cases by graphical method. algebraic and linear programming solution of m x n games.	9

Suggested Readings (Part-A Number Theory):

1. Niven, I., Zuckerman, H. S. and Montegomery, H. L. **An Int. to the Theory of Numbers** John Wiley and sons, 2003
2. Burton, D. M., **Elementary Number Theory** (4th edition) Universal Book Stall, 2002
3. Balakrishnan, V. K., **Schaum's Outline of Theory and Problems of Combinatorics Including Concepts of Graph Theory**, Mc Graw Hill, 1995
4. Balakrishnan, V. K., **Introductory Discrete Mathematics**, Dover Publications, 1996
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Readings (Part-B Game Theory):

1. Martin Osborne, **An Introduction to Game Theory**, Oxford University Press, 2003
2. Vijay Krishna, **Game Theory**, Academic Press.
3. Prajit Dutta, **Strategies and Games**, MIT Press, 1999 (Website 1) http://www.ece.stevens-tech.edu/~ccomanic/ee800c.html
4. Allan Mac Kenzie, **Game Theory for Wireless Engineers**, Synthesis lectures on Communications, 2006
5. Suggested digital platform: NPTEL/SWAYAM/MOOCS

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc. (C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	10
2	**Online Quizzes/ Objective Tests**	5
3	**Presentation**	5
4	**Assignment**	5

Course prerequisites: To study this course, a student must have Diploma in Mathematics

Suggested equivalent online courses:

Further Suggestions:

B.A./B.Sc. III (SEMESTER-V) PAPER-II (ii) Graph Theory & Discrete Mathematics

Programme: Degree Class: B.A./B.Sc.	Year: Third	Semester: Sixth
Subject: Mathematics		
Course Code: B030502T	Course Title: Graph Theory & Discrete Mathematics	

Course outcomes:

CO1: Upon successful completion, students will have the knowledge of various types of graphs, their terminology and applications.

CO2: After Successful completion of this course students will be able to understand the isomorphism and homomorphism of graphs. This course covers the basic concepts of graphs used in computer science and other disciplines. The topics include path, circuits, adjacency matrix, tree, coloring. After successful completion of this course the student will have the knowledge graph coloring, color problem, vertex coloring.

CO3: After successful completion, students will have the knowledge of Logic gates, Karnaugh maps and skills to proof by using truth tables. After Successful completion of this course students will be able to apply the basics of the automation theory, transition function and table.

CO4: This course covers the basic concepts of discrete mathematics used in computer science and other disciplines that involve formal reasoning. The topics include logic, counting, relations, Hasse diagram and Boolean algebra. After successful completion of this course the student will have the knowledge in Mathematical reasoning, combinatorial analysis, discrete structures and Applications.

Credits: 5	Core Compulsory / Elective
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0

Part- A
Graph Theory

Unit	Topics	No. of Lectures
I	Introduction to graphs, basic properties of graphs, Simple graph, multi graph, graph terminology, representation of graphs, Bipartite, regular, planar and connected graphs, connected components in a graph, Euler graphs, Directed, Undirected, multi-graph, mixed graph.	10
II	Walk and unilateral components, unicursal graph, Hamiltonian path and circuits, Graph coloring, chromatics number, isomorphism and homomorphism of graphs, Incidence relation and degree of the graph.	9
III	Operation of graph circuit, Path and circuits, Eulerian circuits, Hamiltonian path and cycles, Adjacency matrix, Weighted graph, Travelling salesman problem, shortest path, Dijkstra's algorithm.	9
IV	Tree, Binary and Spanning trees, Coloring, Color problems, Vertex coloring and important properties.	9

Part- B
Discrete Mathematics

Unit	Topics	No. of Lectures
V	**Propositional Logic-** Proposition logic, basic logic, logical connectives, truth tables, tautologies, contradiction, normal forms (conjunctive and disjunctive), modus ponens and modus tollens, validity, predicate logic, universal and existential quantification, proof by implication, converse, inverse contrapositive, contradiction, direct proof by using truth table.	10
VI	**Relation**- Definition, types of relation, domain and range of a relation, pictorial representation of relation, properties of relation, partial ordering relation. Representation of POSETS using Hasse diagram, Chains, Maximal and Minimal point. Glb, lub, Lattices and Algebraic system, Basic properties, Sublattices.	10
VII	**Boolean Algebra-** Basic definitions, Sum of products and products of sums, Boolean Functions, Disjunctive normal form, Complete Disjunctive normal form, conjugate normal form, Logic circuits, Logic networks, Design of circuits from given properties, Logic gates, and Karnaugh maps.	9
VIII	**Combinatorics-** Inclusion- exclusion, recurrence relations (nth order recurrence relation with constant coefficients, Homogeneous recurrence relations, Inhomogeneous recurrence relations), generating function (closed form expression, properties of G.F., solution of recurrence relations using G.F. solution of combinatorial problem using G.F.	9

Suggested Readings (Part-A Graph Theory):

1. Narsingh Deo, **Graph Theory with Applications to Engineering and Computer Science**, Dover Publications, 2017
2. Douglas B West**, Introduction to Graph Theory**, Pearson, 2018
3. Santanu Saha Ray, **Graph Theory with Algorithms and Its Applications: In Applied Science and Technology**, Springer India, 2012
4. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Readings (Part-B Discrete Mathematics):

1. C. L. Liu., **Discrete Mathematics**, Tata McGraw Hill, 1986
2. Trembley and Manohar, **Discrete Mathematics with computer application**, Tata McGraw Hill, 2008
3. Kenneth H. Rosen, **Discrete Mathematics and Its Applications**, McGraw-Hill Companies, 2012
4. Suggested digital platform: NPTEL/SWAYAM/MOOCS

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	10
2	**Online Quizzes/ Objective Tests**	5
3	**Presentation**	5
4	**Assignment**	5

Course prerequisites: To study this course, a student must have Diploma in Mathematics

Suggested equivalent online courses:

Further Suggestions:

B.A./B.Sc. III (SEMESTER-V) PAPER-II (iii) Differential Geometry & Tensor Analysis

Programme: Degree Class: B.A./B.Sc.	Year: Third	Semester: Sixth
Subject: Mathematics		
Course Code: B030502T	Course Title: Differential Geometry & Tensor Analysis	

Course Otcomes

CO1: After Successful completion of this course, students should be able to determine and calculate curvature of curves in different coordinate systems.

CO2: This course covers the Local theory of Curves, Local theory of surfaces, Geodesics, Geodesics curvature, Geodesic polars, Curvature of curves on surfaces, Gaussian curvature, Normal curvature etc.

CO3: After Successful completion of this course, students should have the knowledge of tensor algebra, different types of tensors, Riemannian space, Ricci tensor, Einstein space and Einstein tensor etc.

Credits: 5	Core Compulsory / Elective
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 5-0-0

Part- A
Differential Geometry

Unit	Topics	No. of Lectures
I	Local theory of curves-Space curves, Examples, Plane Curves, tangent and normal and binormal, Osculating Plane, normal plane and rectifying plane, osculating circle, osculating sphere Helices, Serret-Frenet apparatus, contact between curve and surfaces, tangent surfaces, involutes and evolutes of curves, Bertrand curves, Intrinsic equations, fundamental existence theorem for space curves.	10
II	Local Theory of Surfaces-Tangent plane, Normal, Parametric patches on surface curve of a surface, family of surfaces (one parameter), edge of regression, rues surfaces, skew ruled surfaces and developable surfaces.	9
III	Metric-first fundamental form and second fundamental form and arc length, Direction coefficients, families of curves, intrinsic properties.	9
IV	Gauss-Bonnet theorem, curvature of curves on surfaces, Gaussian curvature, normal curvature, Meusneir's theorem, mean curvature, umbilic points, lines of curvature, Rodrigue's formula, Euler's theorem.	9

Part- B
Tensor Analysis

Unit	Topics	No. of Lectures
V	Tensor algebra: Vector spaces, the dual spaces, tensor product of vector spaces, transformation formulae, contraction, special tensors, symmetric tensor, inner product.	10
VI	Tensor Analysis: Contravariant and covariant vectors and tensors, Mixed tensors, Symmetric and skew-symmetric tensors, Algebra of tensors, Contraction and inner product, Q uotient theorem, Reciprocal tensors. Christoffel's symbols, Law of transformation of Christoffel's symbols,	10
VII	Gradient of scalars, Divergence of a contravariant vector, covariant vector and conservative vectors, Laplacian of an invariant, curl of a covariant vector.	9
VIII	Riemannian space, Riemannian curvatures and their properties, geodesics, geodesic curvature, geometrical interpretation of curvature tensor.	9

Suggested Readings (Part-A Differential Geometry):

1. T.J. Willmore, **An Introduction to Differential Geometry**, Dover Publications,2012.
2. B. O'Neill, **Elementary Differential Geometry**, 2nd Ed., Academic Press, 2006.
3. C.E. Weatherburn, **Differential Geometry of Three Dimensions**, Cambridge University Press 2003.
4. D.J. Struik, **Lectures on Classical Differential Geometry**, Dover Publications,1988.
5. S. Lang, **Fundamentals of Differential Geometry**, Springer,1999.
6. B. Spain, **Tensor Calculus: A Concise Course**, Dover Publications,2003.
7. L. P. Eisenhart, **An Introduction to Differential Geometry** (with the use of tensor Calculus), Princeton University Press,1940.
8. I. S. Sokolnikoff,**Tensor Analysis, Theory and Applications to Geometry and Mechanics of Continua**, 2nd Edition, John Wiley and Sons.,1964.
9. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Readings (Part-B Tensor Analysis):

1. Z. Ahsan, **Tensors- Mathematics of Differential Geometry,** PHI, 2015
2. David C. Kay, **Tensor Analysis, Schaum's Outline Series**, McGraw Hill 1988.
3. R. S, Mishra, **A Course in Tensors with Applications to Riemannian Geometry**, Pothishala Pvt. Ltd, 1965
4. Suggested digital platform: NPTEL/SWAYAM/MOOCS

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/ Objective Tests	5
3	Presentation	5
4	Assignment	5

Course prerequisites: To study this course, a student must have Diploma in Mathematics

Suggested equivalent online courses:

Further Suggestions: