

**Semester VI**  
**6S Mathematics Paper- XI(Linear Algebra)**

**Unit I :** Vector Space : Definition and example of vector spaces, subspaces, sum and direct sum of subspaces, linear span, linear dependence, independence and their basic properties, finite dimensional vector spaces ,existence theorem for bases, invariance of the number of basis set, dimension.

**Unit II:** Linear transformations: Linear transformation and their representation as matrices, algebra of linear transformations, rank nullity theorem, change of basis.

**Unit III :** Dual Spaces: Dual space, bidual space and natural isomorphism, adjoint of a linear transformation, Eigen values and eigenvectors of a linear transformation.

**Unit IV :** Inner Product Spaces: Inner product spaces, Cauchy-Schwarz inequality, orthogonal vectors, orthogonal complements, orthonormal sets and bases, Bessel's inequality for finite dimensional spaces, Gram Schmidt orthogonalisation process.

**Unit V:** Modules: Modules, submodules, quotient modules, homomorphism and isomorphism theorems.

**Reference Books:**

1. I. N. Herstein: Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. N. Jacobson: Basic Algebra, Vol. I and II, W.H. Freeman, 1980. (Hindustan Publishing Co.)
3. Shanti Narayan :A Text Book Of Modern Abstract Algebra, S. Chand and Co. ,New Delhi
4. K. B. Datta: Matrix and Linear Algebra, Prentice Hall of India Pvt. Ltd. New Delhi, 2000
5. P.B. Bhattacharya, S. K. Jain and S. R. Nagpal :Basic Abstract Algebra (IInd Edition)Cambridge University Press Indian Edition, 1997
6. K. Hoffman and R. Kunze: Linear Algebra, IInd Edition Prentice Hall, Englewood Cliffs, New Jersey, 1971.
7. S. K. Jain, A Gunawardhana and P. B. Bhattacharya: Basic Linear algebra with MATLAB, Key College Publishing (Springer- Verlag), 2001.
8. S. Kumaresan : Linear Algebra, A Geometric Approach P Prentice Hall of India Pvt.Ltd. New Delhi, 2000.
9. Vivek Sahai and Vikas Bisht :Algebra, Narosa Publishing House , 1997.
10. D. S. Malik, J . N. Mordeson and M. K. Sen : Fundamentals of Abstract Algebra, McGraw Hill International Edition 1997 .
11. T. M. Karade, J.N. Salunke, K. S. Adhav, M. S. Bendre : Lectures on Abstract Algebra. Sonu Nilu Publication. Nagpur (IInd Publication).
12. John B. Fraleigh : A First course in Abstract Algebra.

13. Joseph A. Gallian: Contemporary Abstract Algebra, Narosa publishing house.
14. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul: First Course in Linear Algebra.
15. V. Krishnamurty , V. P. Mainru, J.L. Arora: An Introduction to linear Algebra.
16. L Smith: Linear Algebra, Springer- Verlag New York.

## Semester VI

### 6 S - Paper- XII (Optional) ( Graph Theory )

**Unit I :** Graph. Application of graphs, finite and infinite graphs, incidence and degree, isolated vertex, pendent vertex and null graph, isomorphism, sub graphs, walks, path and circuits, connected graphs and components, Euler graph, operation on graphs, Hamiltonian paths and circuits, travelling salesman problem.

**Unit II :** Trees, some properties of trees, pendent vertices in a tree, distance and centres in a tree, Rooted and binary trees, On counting trees, spanning trees.

**Unit III :** Fundamental circuits, Cutsets, Some properties of cutesets, all cuteset in agraph, Fundamental circuits and cutsets, connectivity and separability, planer graphs, Kurutowski's two graphs, different representation of planer graph, detection of planarity.

**Unit IV:** Vector space associated with a graph, circuit and cuteset subspaces, Orthogonal vectors and spaces, Intersection and join of  $W_{\Gamma}$  and  $W_s$  .

**Unit V :** Incidence matrix, Submatrix of  $A(G)$ , Circuit matrix, Fundamental circuit matrix  $B$ , Rank of  $B$ , an application to a switching network, cuteset matrix, path matrix, adjacency matrix, the relationship among  $A_f$  ,  $A_r$  and  $C_f$  .

#### Reference Books:

1. Narsingh Deo: Graph Theory with Application to Engineering and Computer Science, Prentice Hall Of India, New Delhi.
2. Richard Johnson- Baugh : Discrete Mathematics, Macmillan Publishing Company 886, Third Avenue New York 10022
3. Olympia Nicodemi : Discrete Mathematics, C.B.S Publ. and Distributors 485, Jain Bhavan Bholanath Nagar Shahadara, New Delhi- 32 India
4. Frank Harare : Graph Theory , Narosa Publishing House , 307 , Shiv Centre D.B.C. Sector Ku Bazar New Bombay 400704,
5. S.A. Choudum: A first Course In Graph Theory, McMillan India Ltd. Mercatile House Magazine Street Bombay 10
6. E.L.LIU : Elements of Discrete Mathematics, McGraw Hill Book Company, New York
7. Seymour Lipschultz and Marc Lipson : Discrete Mathematics , TMH New Delhi (Schaum Outline series) II Ind Edition.
8. J .N.Salunke : Boolean Algebra and Graph Theory, Laxmi Publication Akot.

## Semester- VI

### 6S Mathematics Paper- XII (Special Theory of Relativity) ( Optional )

**Unit - I : Review of Newtonian Mechanics.** Inertial frames, speed of light and Galilean relativity, relative character of space and time, postulates of special theory of relativity, Lorentz transformation and its geometrical interpretation, group properties of transformation.

**Unit- II: Relativistic Kinematics.** Composition of parallel velocities, length contraction, time dilation, transformation equation for components of velocities and acceleration of a particle, Lorentz contraction factor.

The thermodynamics of moving systems : The two laws of thermodynamics for a moving system, the Lorentz transformation for thermodynamics quantities a) volume and pressure b) energy c) work d) heat e) entropy f) temperature.

**Unit- III: Geometrical representation of space- time.** Four dimensional Minkowskian space-time of relativity, time like and space like intervals , proper time, world line, four vectors and tensors in Minkowskian space- time, past, present and future null cone, basic tensors, covariant, contrvariant, mixed, operations on tensors, outer product, inner product, quotient law.

**Unit- IV: Relativistic Mechanics.** Variation of mass velocity, equivalence of mass and energy, transformation equation for mass, momentum and energy, relativistic force and transformation equations for its components, relativistic Lagrangian and Hamiltonian, the energy momentum tensor.

**Unit- V: Electromagnetism:** Maxwell's equations of electromagnetic theory in vacuum, propagation of electric and magnetic field strengths , scalar and vector potential, transformation of electromagnetic four potential vector, transformation of charged density and current density, Lagrangian for a charged particle in electromagnetic field, the force on a moving charged- Lorentz force, Gauge transformation, four dimensional formulation of the theory, Maxwell's equation in tensor form, transformation for electric and magnetic field strength, energy momentum tensor of the electromagnetic field. component of  $T^{ij}$  in term of electric and magnetic strength.

#### Reference Books:

1. C. Molar: The Theory of Relativity, Oxford Clarendon Press, 1952.
2. P. G. Bergman : Introduction to The Theory of Relativity, Prentice Hall of India, Pvt.Ltd.1969.
3. T.M. Karade, K.S. Adhav and M.S. Bendre: Lectures on Spacial Theory of Relativity, Sonu-Nilu Publication, Nagpur
4. J . L. Anderson : Principles of Relativity Physics, Academic Press, 1967.
5. V. A. Ugarov : Special Theory of Relativity, Mir Publishers, 1979.
6. R. Resnick : Introduction to Special Relativity Wiley Eastern, Pvt. Ltd.1972.

## Semester VI

### 6S Mathematics Paper- XII (Mathematical Modelling) ( Optional )

**Unit- I :** The Process of applied mathematics. Setting of First- order differential equations – Qualitative Solutions Sketching.

**Unit- II :** Difference and Differential Equation growth models – single species population models. Population growth- An age structure model. The spread of Technological innovation.

**Unit- III :** Higher order linear models - A model for the detection of diabetes. Combatmodes. Traffic models - Car- following models. Equilibrium speed distributions.

**Unit- IV :** Non- linear population growth models. Prey- Predator models. Epidemic growth models. Models from political Science - Proportional representation -cumulative voting, comparison voting.

**Unit- V :** Applications in Ecological and Environmental subject areas - Urban waste water management planning.

#### References Books:

1. Vol.1. Differential equation models, Eds. Martin Braun, C.S. Coleman, D.A.Drew.
2. Vol.2. Political and Related Models. Steven J .Brams, W.F. Lucas, P.D. Straffin (Eds)
3. Vol.3. Discrete and System models. W.F. Lucas, F.S. Roberts, R.M. Thrall.
4. Vol.4. Life Science Models. H.M. Roberts & M. Thompson.
5. All Volumes published as modules in Applied Mathematics, Springer- Verlag, 1982.

\*\*\*\*\*