Krishna Kanta Handiqui State Open University

Four Year Undergraduate Programme

(As per NEP 2020)

Syllabus of Mathematics as Minor/Elective

Semester	Name of the Courses	Credit
I	Classical Algebra & Trigonometry	4
II	Abstract Algebra & Discrete Mathematics	4
Exit 1	**UG Certificate**	
III	Differential Calculus	4
IV	Integral Calculus & Differential Equations	4
Exit 2	**UG Diploma**	
V	Analytical Geometry and Vector Calculus	4
VI	Mechanics and Elements of Statistics	4
Exit 3	**UG Degree (General)**	
VII	Real Analysis	4
VIII	Operation Research	4
Exit 4	**UG Degree (Honours/Research)**	

DETAILED SYLLABUS

SEMESTER I: Minor 1: Classical Algebra & Trigonometry

Course Type:	**Minor**
Number of Credits:	**4**
Total Marks:	**100** (I.A**:30,** E.S.E**: 70)**

Course Objectives

- To provide learners the concept of theory of equations, relation between the roots and coefficients and symmetric functions of the roots.
- To provide learners the knowledge about Inequalities, Matrices and determinants, Adjoin of a square matrix, Cramer's rule, Rank, Eigen values, Eigenvectors.

Course Outcomes

- Solve higher order algebraic equations
- Learn to solve system of linear equations
- Determine the rank of a matrix, Eigen values, Eigen Vectors andInverse of a matrix.
- Employ De Moivre's theorem in a number of applications to solve numerical problems.
- Learn about matrices, determinant and application in solving system of equations.
- sum the trigonometric series of real and complex numbers and separate the trigonometric function in form of A+iB

UNIT-1: **Theory of Equation-I**: Polynomial equations, Relation between roots and coefficients and related problems, Symmetric functions of roots

UNIT 2: **Theory of equation-II**: Cardon's method of solution of cubic equation, Descartes' rule of sign, Cardan's Solution of the Standard cubic.

UNIT 3: **Inequalities**: Definition, properties, Inequalities involving arithmetic, geometric and harmonic means

UNIT 4: **Determinant**: Definition and examples, properties (without proof), problems on determinants (using properties).

UNIT-5: **Matrices**: Definition of Matrix and Examples, Types of matrices, algebra of matrices: Addition of matrices, scalar multiplication, subtraction of matrices, multiplication of matrices:

UNIT-6: **Adjoint and Inverse of a Matrix**: Transpose of a matrix, symmetric and skew-symmetric matrix, Adjoin and inverse of a matrix and its existence,

UNIT 7: **Rank and Elementary Operations**: Definition of rank of a matrix, Elementary operations, Inverse Using Elementary operations.

UNIT 8: **System of Linear Equations**: Solution of a system of linear equations by matrix method, Solution of a system of linear equations by Cramer's rule

UNIT 9: **Eigen Values and Eigen Vectors**: Characteristic equation of a matrix, Characteristic matrix, Definition, properties of eigenvalues and eigenvectors, Statement, Verification of Cayley Hamilton Theorem, finding inverse using Cayley Hamilton Theorem

UNIT-10: **De Moivre's theorem and its application:** Statement and proof, Important deductions from De Moivre's theorem, Extraction of roots of complex numbers, solution of equation.

UNIT-11: Expansion of Trigonometric function: Expansion for cosine and sine.

UNIT 12: **Hyperbolic function**: Definition & Examples, Relation between Hyperbolic Functions - Inverse Hyperbolic Functions.

UNIT 13: **Logarithm of a complex number**: Definition, Examples

UNIT 14: **Trigonometric series**: Gregory Series and other related series, Summation of trigonometric series (when the angles are in A.P, C+iS method, Method of differences)

Suggestive Readings:

1. University Algebra - N S Gopala Krishnan, New Age International (P) Limited.
2. Theory of Matrices - B S Vatsa, New Age International Publishers.
3.Trigonometry, for B. A/B.Sc. Classes (1st Edition), N.P. Bali: Laxmi Publication (P) Ltd.
4. Trigonometry; (1st Edition), Hari Kishan: Atlantic Publishers.
5. Linear Algebra: Schum Solved Problems Series; Seymour Lipschitz: Tata McGraw Hill.

SEMESTER II: Minor 2: Abstract Algebra & Discrete Mathematics

Course Type:	**Minor**
Number of Credits:	**4**
Total Marks:	**100 (**I.A**:30,** E.S.E**: 70)**

Course Objectives

- To introduce the basic concepts of group theory, ring theory and their properties
- To introduce the basic concept of discrete mathematics.

Course Outcomes

- Understand the basic concepts of relations and functions
- gets a concept of group, ring, Integral domain and vector space and their properties
- Learn about Lagrange's theorem.
- Know about group homomorphisms and group isomorphisms
- Know the basic concepts of discrete mathematics.

UNIT 1: **Relation &Functions**: Relations and Types of relations, equivalencerelation, function and types of function.

UNIT 2:**Binary Operation**:Definition, Types of binary operation

UNIT 3: **Group: Definitions** and Examples of groups, Properties of groups

UNIT 4:**Subgroups:**Definition, Examples, Properties, cyclic groups,

UNIT 5:**Group of permutation**: Definition of permutation, different kinds of permutation, permutation group.

UNIT 6: **Cosets**:Definition, properties of cosets, Lagrange's Theorem

UNIT 7:**Normal subgroups &Quotient groups**: Definition and Examples, properties.

UNIT 8:**Homomorphism of groups**: Definition and Examples, Properties of Homomorphism

UNIT-9: Ring: Definitions and Examples of Rings, Properties of Ring

UNIT 10:**Integral domain & Field**: Definition and Examples, Properties.

UNIT 11:**Vector Space**: Definition and Examples, Subspace, Properties, Linear dependence and Independence, Basis and Dimension.

UNIT-12: **Combinatorics**: The rules of sum and product, permutations, combinations.

UNIT-13: **Mathematical Logic**: Propositions and Logical connectives, Truthtable, construction of truth tables, tautologies and contradictions, Equivalence and Implication.

UNIT 14: **BooleanAlgebra:**Definition, Basic Boolean algebra Laws, Boolean expression.

Suggestive Readings:

1.Topics in Algebra, I N Herstein, Wiley Eastern Ltd., New Delhi.

2.A Course in Abstract Algebra, Vijay K Khanna and S K Bhambri, Vikas Publications
3. Higher Algebra (Abstract and Linear) (1994), S.K. Mapa: Ashok Prakashan.
4. A Course in Abstract Algebra: V.K. Khanna, S.K. Bhambri: Vikas Publishing House Pvt. Ltd.
5. Modern Algebra: Surajeet Singh, QaziZameeruddinVikas Publishing House Pvt. Ltd.
6.Contemporary Algebra (1977), B.K. Tamuli: New Book Stall, Guwahati- 781 001.
7. Discrete Mathematics, J.K. Sharma: Macmillian Publishing India Ltd.

SEMESTER III: Minor 3: Differential Calculus

Course Type:	**Minor**
Number of Credits:	**4**
Total Marks:	**100 (**I.A**:30,** E.S.E**: 70)**

Course Objectives

- To introduce the basic tools of differential calculus
- To introduce the concept of Differentiation. Successive differentiation, Partial differentiation, Maxima and minima of functions of two variables
- To calculate the limit of indeterminate form
- To make the knowledge about Tangents, normal, curvature

Course Outcomes

- Learn first and second derivative tests for relative extrema and apply the knowledge in problems in business, economics and life sciences.
- Learn differentiability, limit and continuity tests for functions
- Understand concept of differentiation, partial differentiation, maxima and minima with examples.
- Understand tangent, normal and curvature with examples
- Identify and apply the mean value theorems and L'Hospital's rule
- Use Leibnitz's rule to evaluate derivatives of higher order

UNIT-1: **Function**: Definition, Domain and range, Classification of a function.

UNIT -2: **Limit of a function**: Concept of limit of a function, properties.

UNIT- 3: **Continuity of a function**: Definition and examples, properties

UNIT -4: **Differentiability of a function**: Definition and Examples, properties

UNIT-5: **Derivative of a function:** Derivative of various standard function, Derivative of sum and difference of functions, Derivative of product of functions, Quotient rule,

UNIT- 6: **Derivative of some special function**: Derivative of trigonometric functions, Derivative of exponential and logarithmic function. Logarithmic Differentiation,Derivative of hyperbolic function.

UNIT- 7: **Indeterminate forms**: Definition, L Hospital's Rules, Forms $\frac{0}{0}, \frac{\infty}{\infty}, 0.\infty,$

$\infty - \infty, 0^0, 1^\infty, \infty^0$**UNIT-8**: **Successive differentiation**: Leibnitz's theorem for the nth derivative of the product of two functions, problems.

UNIT-9: **Application of derivatives**: Increasing and Decreasing of a function, Derivatives as rate measurer, Maximum and minimum of a function, Curvature, tangent and normal.

UNIT-10: **Mean Value theorem**: Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem,

UNIT-11: **Function of several variables**: Partial Derivatives, homogeneous function, Euler's theorem on homogeneous function.

UNIT-12: **Extreme value of a function of several variables:** Maximum and minimum of a function of two variables, Definition, Examples, Application.

UNIT -13: **Jacobians**: Definition, its properties.

UNIT- 14: **Lagrange method of undetermined multipliers:** Statement, Application

Suggestive Readings:

1.Differential Calculus - Shanti Narayan, S. Chand & Company, New Delhi.

2. Calculus - S Narayanan & T K Manicavachogam Pillay, S Viswanathan Pvt. Ltd., vol. I & II.

3. Schaum's Outline of Calculus - Frank Ayres and Elliott Mendelson, 5th ed. USA: Mc. Graw.

4. Calculus - S Narayanan & T K Manicavachogam Pillay, S Viswanathan Pvt. Ltd., vol. I & II.

5. Differential Calculus; H. S. Dhami, New Age International(P) Limited Publishers.

6. Basics of Differential Calculus; Sudhir Gupta: Anmol publication Pt. Ltd.

7. Differential Calculus; Hari Kishan: Atlantic Publishers Distributors (P) Ltd.

8. Differential Calculus; Shanti Narayan: S. Chand Limited.

9. Differential Calculus; S. Rao Berkeley: University of California Press.

SEMESTER IV: Minor 4: Integral Calculus & Differential Equations

Course Type:	**Minor**
Number of Credits:	**4**
Total Marks:	**100 (**I.A**:30,** E.S.E**: 70)**

Course Objectives

- To understand the concept of Integration, Definite integrals and their properties, Reduction formulae.
- To know about Differential equations of homogeneous equations in x and y, First order linear equations, Linear equations of order 2 with constant coefficients
- To introduce the concepts of Partial differential equations of first order

Course Outcomes

- Identify an ordinary differential equation and its order
- Classify ordinary differential equations into linear and nonlinear equations
- Solve first order linear differential equations
- Find the general solution of second order linear homogeneous equations with constant coefficients
- Use the method of variation of parameters to find particular solutions of second order, linear homogeneous equations
- Solve first order non-linear differential equations and linear differential equations of higher order using various techniques.
- Solve the Partial Differential Equations of the first order
- Understand Lagrange's method for solving PDE's of first order

UNIT-1: **Integration and Methods of Integration:** Introduction, Integration of simple functions, Properties of Integrals, Methods of integration: Integration by substitution, Integration by parts, Integration by Partial fraction.

UNIT2: **Definiteintegrals**: Definition, Fundamental properties of definite integrals, Evaluation of definite integrals by using properties only.

UNIT-3:**Reduction formulae**: Derivation of some reduction formulae

UNIT 4: **Quadrature of plane areas**: Definition, Areas in Cartesian coordinates, Areas bounded by two curves.

UNIT-5: **Rectification of plane curves**:Definition, Formula for Cartesian equation

UNIT-6: **Volume of revolution and surface of revolution**: Volume of revolution about x-axis, Area of the curved surface of a solid of revolution about x-axis.

UNIT-7:**Differential Equation: Fundamentalconcepts:** Definition and Examples, Order and degree of ordinary differential equation, Linear and non-linear differential equation, Formation of a differential equation.

UNIT-8: **Differential equation of first order and first degree:** Solution of differential equation, Differential equation of first order and first degree; solution by variable separable methods; homogeneous equations, linear equations and Bernoulli's equation, exact differential equations.

UNIT-9: Application of differential equation of first order and first degree: Problems related to economics.

UNIT-10: **First order and higher degree differential equation:** First order higher degree equations solvable for x, y and p, Clairaut's form.

UNIT-11: **Linear differential equation of higher order:** Linear differential equation of higher order with constant coefficients,

UNIT 12: **Simultaneous linear differential equation**: Simultaneous equation of the first order

UNIT 13: **Partial differential equation**: Formation of Partial differential equation,

UNIT 14: **Linear partial differential equation**: Solution of first order and first degree partial differential equation, Lagrange's solution of linear equation.

Suggestive Readings:

1.Integral Calculus, Shanti Narayan and P K Mittal, S. Chand and Co. Pvt. Ltd.,
2. Ordinary and partial differential equation, M.D. Raisinghania, S. Chand & company Ltd.
3. Advanced differential Equations, Sharma, A. K. Sharma Discovery Publishing House.
4. Higher Engineering Mathematics, B.V. Ramana, Tata McGraw Hill Education Private Ltd.

SEMESTER V: Minor 5: Analytical Geometry and Vector Calculus

Course Type:	**Minor**
Number of Credits:	**4**
Total Marks:	**100 (**I.A**:30,** E.S.E**: 70)**

Course Objectives

- Find the direction cosines and cross product of two vectors in space
- Find the distance between points, planes, and lines in space
- Perform vector operations and interpret the results geometrically
- Find the angle between two vectors using the dot product
- Use the triple scalar product of three vectors in space

Course Outcomes

- Understand the distance between points, the distance from a point to a line, and the distance from a point to a plane in the three-dimensional coordinate system
- Compute dot and cross product of vectors
- Compute scalar and vector projections of a vector onto another and the angle between two vectors.

UNIT-1: Introduction of straight lines: Slope of a line, Various standard forms of equation of straight lines.

UNIT -2: Transformation of coordinate axes: Translation and rotation, Related theories and problems.

UNIT-3: **Pair of straight lines**: Pair of straight lines though origin, Angle and Bisectors of the angle between the lines given by homogenous equation of 2nd degree, Condition for the general equation of second degree to represent a pair of straight lines, Pair of intersecting straight lines, Pair of parallel straight lines.

UNIT-4: **Circle**: Second degree equation of a circle, Equation of a circle when end points of its diameter is given, tangent and normal

UNIT-5: **Conic sections**: Parabola and its standard equation, Ellipse and its standard equation, hyperbola and its standard equation, Conjugate Hyperbola, Conjugate Diameter for Ellipse and Hyperbola.

UNIT-6: **Introduction of co-ordinate in three dimensions**: Coordinate axes, Direction cosine of a line, direction ratio of a line

UNIT -7: The Plane: Equation of a plane, Various forms of the equation of a plane

UNIT 8: The straight line: The straight line, The shortest distance (S.D) between two lines
UNIT- 9: **Sphere**: Definition and General equation of Sphere.

UNIT -10:Cone: Definition and General equation of Cone.

UNIT -11: **Cylinder**: Definition and General equation of Cylinder.

UNIT-12:Introduction to Vectors: Classification of vectors, Algebra of vectors: Addition of vectors, subtraction of vectors, Multiplication vectors by scalars.

UNIT-13: **Product of Vectors-I**: Scalar or dot product and cross or vector product of two vectors, Properties and problems.

UNIT -14: Product of vectors-II: Geometrical meaning of scalar triple product, product of four vectors.

UNIT -15: Vector Calculus: Scalar and Vector point function, Vector differential operator (del), Gradient, divergence and Curl and their Identities, Laplacian operator.

Suggestive Readings:

1.Analytical Geometry of Two & Three Dimensions & Vector Analysis. Khan New Central

Book Agency (P) Limited.

2.Coordinate Geometry of Two dimensions. Hari Kishan: Atlantic Publishers & Distributors.

3.Vector Algebra and Calculus. Hari Kishan: Atlantic Publishers & Distributors (P) Ltd.

4.Coordinate Geometry (2D). A.K. Sharma: Discovery Publishing House.

5.Textbook of Vector Calculus. A.K. Sharma: Discovery Publishing House.
6.Analytical Geometry of Three Dimensions (Coordinate of Solid Geometry). A.R. Vasishta, D.C. Agrawal.

SEMESTER VI: Minor 6: Mechanics and Elements of Statistics

Course Type:	**Minor**
Number of Credits:	**4**
Total Marks:	**100 (**I.A**:30,** E.S.E**: 70)**

Course Objectives

- To know about the concepts in statics such as moments, couples, equilibrium in both two and three dimensions
- To know about the concepts in statics such as moments, couples, equilibrium in both two and three dimensions
- To know about various univariate distributions such as Bernoulli, Binomial
- To find friction, coefficient of friction and angle of friction

Course Outcomes

- To get the knowledge of the principles of statics
- Know about friction and laws of friction.
- Understand S.H.M, velocity, acceleration
- Understand the concept of random experiment and probability

UNIT-1:Forces: Types of forces, Magnitude and direction of the resultant of the forces acting on a particle.

UNIT-2: **Coplanar forces:** Trianglelaw of forces, polygon of forces, Lami's theorem, equilibrium of a particle under several coplanar forces, parallel forces, moments, couples-simple problems, Friction.

UNIT -3: Moments and couples: Definition and examples, simple problem.

UNIT-4:Friction:Definition, types of friction, laws of friction, simple problems.

UNIT-5: **Kinematics of a particle:** kinematics of a particle, velocity, acceleration, relative velocity, angular velocity, Newton's laws of motion, equation of motion, rectilinear motion under constant acceleration,

UNIT-6Simple harmonic motion: simple harmonic motion and related problems

UNIT 7:**Measures of Centraltendency**: Introduction, Arithmetic mean (A.M.), Properties of arithmetic mean, Median, Mode, Geometric mean (G.M.), Harmonic mean (H.M.).

UNIT-8: **Measures of Dispersion**: Range, Quartile deviation, Meandeviation, Standarddeviation, co-efficient of variation.

UNIT 9:**Moments, Skewness&Kurtosis**:Moments, Moments –raw and central, Relation between raw and central moments, Skewness, Measures of skew ness, kurtosis, Measures of kurtosis

UNIT-10: **Probability**: Basic terminology: Random experiment, sample space, events, Classical definition of probability, Axiomatic approach to probability. Some theorems on probability.

UNIT-11: **Conditional probability**: Multiplication theorem of probability, Independent events, Multiplication theorem of probability for independent events, Extension of multiplication theorem of probability, Law of Total probability, Bayes theorem.

UNIT 12:**Random variables and probability distribution:**Definition (discrete and continuous type)

UNIT 13:Theoretical Distribution-I:Standard Distributions: Discrete type Bernoulli, Binomial, Poisson distributions (definition, properties and applications).

UNIT 14: **Theoretical Distribution-II**: Continuous type, Normal (definition, properties and application

Suggestive Readings:

1.Fundamentals of Mathematical Statistics, Gupta S. C. and Kapoor V. K.:, Sultan Chand and Sons, New Delhi.

2.Fundamentals of Statistics, Goon A. M., Gupta, M. K. and Dasgupta, B. World Press Calcutta.

3.Applied Statistics, Mukhopadhya Parimal New Central Book Agency Pvt. Ltd. Calcutta.

4.Fundamentals of Applied Statistics, Gupta S. C. and Kapoor V. K., Sultan Chand and Sons, New Delhi.

5. Elementary statistics, H.C. Saxena, S. Chand & Company Ltd., 2002.

6. Basic Statistics, B.L. Agarwal, New Age International Publishers, 2009

SEMESTER VII: Minor 7: Real Analysis

Course Type:	**Minor**
Number of Credits:	**4**
Total Marks:	**100 (**I.A**:30,** E.S.E**: 70)**

Course Objectives

- To define functions between sets; equivalent sets; finite, countable and uncountable sets.
- Recognize convergent, divergent, bounded, Cauchy and monotone sequences.
- To define sequences and identify the different kinds of sequences

Course Outcomes

- Understand concept of sequences, series and its various types with examples.
- Understand the types of tests with examples.
- Understand the fundamental properties of the real numbers, including completeness and Archimedean, and density property of rational numbers in $\mathbb{R}$.
- Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate the limit superior and limit inferior of a bounded sequence.
- Understand how the elementary functions can be defined by power series, with an ability to deduce some of their easier properties.
- Learn the concept of Convergence and Divergence of a sequence

UNIT -1: Sets and Functions: Sets, Equality of sets, Different kinds of sets, Algebraic operations on sets, Functions, Real valued functions of a real variable, Absolute value of a real numbers

UNIT -2: Real number System-I: Natural numbers, Integers, Rational numbers,Real numbers, The real line, Order properties of R, Intervals

UNIT-3: **Real number System-II:**Bounded and unbounded sets in Supremum and infimum, Completeness property of R.

UNIT-4: **Real number System-III:**Algebraic properties of R, R is a complete ordered field, Archimedean property of R, Density property of R,

UNIT-5: **Countability of sets:**Equivalent sets, Denumerablesets, Countablesets, Uncountable sets, Countability of rational numbers, Countability of real numbers

UNIT-6: Limit point of a set: Open and Closed sets: Neighbourhood of a point, properties of neighbourhood, Interior point of a set, limit point of a set, open sets, closed sets

UNIT-7: RealSequences-I: Definition, Range of a sequence, Finite and Infinite Sequences, Bounded and unbounded sequence, Convergent sequence, Divergent sequence, Oscillatory sequence, Monotonic sequence, Limit of a Sequence, Basic Theorems of Convergence of Monotonic Sequences.

UNIT-8: RealSequences-II: Cauchy's Sequence, Cauchy's general principle of Convergence, Supremum of a sequence, Infimum of a sequence, Limit superior and limit inferior of Sequence

UNIT-9: **Infinite Series-I**: Introduction, Convergent, divergent and oscillatory series, Cauchy's general principle of convergence of series,

UNIT-10: **Infinite Series-II**: Comparison tests for series of positive terms, The p-test for the series of the type $\sum(\frac{1}{n^p})$. D'Alembert's ratio test, Raabe's Test, Logarithmic Test, Cauchy's root test

UNIT-11: **Power Series**: Introduction, Convergence of power series, Interval of convergence, Radius of convergence, working rule for finding radius of convergence and interval of convergence.

Unit-12: Sequence of Functions: Sequence of real valued functions, Pointwise convergence of a sequence of functions, Uniform convergence of functions, Uniform bounded functions of sequence, Cauchy's criterion for uniform convergence

Unit-13: Tests for Uniform convergence of sequence of functions: Weierstrass'MTest for uniform convergence,Abel's Test and Dirichlet's test

Unit-14: Series of real valued function: Introduction, Pointwise convergence of a series of functions, Uniform convergence of series of functions, Cauchy's criterion for uniform convergence of a series of functions, Weierstrass's M-test

Suggestive Readings:

1. Walter Rudin: Principle of Mathematical Analysis (3rd edition) McGraw-Hill Kogakusha, 1976, International Student Edition.
2. S. C. Malik and Savita Arora, Mathematical Analysis, New Age International Pvt. (Ltd), 2012.
3. Mathematical Analysis, S C Malik, Wiley Eastern
4. Elements of Real Analysis, Shanti Narayana & M.D. Raisinghania, S. Chand& Company Ltd.
5. S.K. Berberian, A First Course in Real Analysis, Springer Verlag, New York, 1994

SEMESTER VIII: Minor 8: Operations Research

Course Type:	**Minor**
Number of Credits:	**4**
Total Marks:	**100 (**I.A**:30,** E.S.E**: 70)**

Course Objectives

- To formulate and model a linear programming problem from a word problem and solve them graphically in 2 and 3 dimensions
- To formulate and solve a number of problems in game theory using various methods.

Course Outcomes

- Understand the concept of operations research methods and its uses in various fields.
- Learn about the graphical solution of linear programming problem with two variables
- Learn about the relation between basic feasible solutions and extreme points

- Understand the theory of the simplex method used to solve linear programming problems.
- Learn about the relationships between the primal and dual problems
- Solve transportation and assignment problems

UNIT 1: Introduction to operations research I: Origin and Development of Operations Research (OR), Nature and Features of Operations Research, Scientific Method in OR, Application of OR, Opportunities and Shortcomings in OR

UNIT 2: Introduction to operations research II: Modelling in OR, Classification of Models, Advantages and Limitations of Models, General solution methods to OR models.

UNIT 3: Linear programming problem (LPP): Linear programming problem (LPP), General form of Linear programming problem(LPP), Some important definitions, Basic assumption of LPP, Application of LPP, Limitations of LPP, Mathematical formulation of a LPP

UNIT 4: Graphical method of solution for LPP: Some basic definition, Graphical methods to solve LPP, Some special cases, Limitations of graphical method

UNIT 5: Simplex Method: Standard Form of Linear Programming Problem (LPP), General LPP, Canonical and Standard Forms of LPP, Solution of LPP, Fundamental Theorem of LPP, the Simplex Algorithm, Big-M Method, Two-Phase Method

UNIT 6: Duality in Linear programming problem: Importance of Duality Concepts, Formulation of Dual Problem, Economic Interpretation of Duality, Sensitivity Analysis

UNIT 7: Transportation Problem: Formulation of Transportation Problem (TP), Basic Theorems on TP, Initial Basic Feasible Solution: North-West Corner Method, Matrix-Minima Method, Vogel Approximation Method, Optimality Test, Algorithm of MODI Method

UNIT 8: Assignment Problem: Formulation of an Assignment Problem, Assignment Problem as a Special Case of Transportation Problem, Solution of an Assignment Problem, The Hungarian Method of Solution of an Assignment Problem, The Travelling Salesman Problem (Shortest Cyclic Route Model)

UNIT 9: Game theory: Competitive Situations, Characteristics of CompetitiveGames, Two-Person Game, Problem, Two-Person Zero-Sum Game, Pay-off Matrix, Strategy,Maximin and Minimax Principle, Saddle Point, Value of a Game, and SymmetricGame, Dominance Property

Unit 10: Project Scheduling and PERT, CPM: Project, Project planning, Project Scheduling Network and its basic components, Procedure relationship, CPM, PERT, Basic difference between PERT and CPM

Unit 11: Sequencing: Definition and examples, Johnson'salgorithm, Three machine problem, Processing of two jobs on 'n' machines

Unit 12: Non-linear Programming: Formulation of a non-linear programming problem (NLPP), General non-linear programming problem, Constrained optimization with equality constraints, Constrained optimization with inequality constaints, Saddle point problems, Saddle points and NLPP

Unit 13: Queueing Theory: Queueingsystem, Elements of a Queueing system, Deterministic Queueing system, Classifications of Queueing models, Poisson Queueing systems

Unit 14: Inventory Control: Inventory problems with uncertain demand, System of Inventory control, One period problem

Unit 15: Replacement Problem: Replacement of Equipment, Replacement of Equipment that fails suddenly, Equipment renewal problem

Suggestive Readings:

1.Linear Programming and Game Theory (2008) by DC Sanyal, K. Das (U N Dhur& Sons Private Ltd. Kolkata 700073)
2.Operations Research: Prem Kuman Gupta, D. S. Hira :S. Chand &Company Ltd.
3.Operations Research: KantiSwarup, P. K. Gupta, Man Mohan (Sultan Chand and Sons)
4.Panneerselvam: Operations Research (2006), Prentice Hall of India Private Limited, New Delhi.