SYLLABUS

FOR

B.SC. (PROGRAMME COURSE)
WITH MATHEMATICS
ON CHOICE BASED CREDIT SYSTEM

A SIX SEMESTERS COURSE

(Effective from the academic session 2017 – 2018 and onwards)

COOCH BEHAR PANCHANAN BARMA UNIVERSITY

COOCH BEHAR, WEST BENGAL

AIMS AND OBJECTIVES OF THE NEW SYLLABUS IN B.Sc.(PROGRAMME COURSE) WITH MATHEMATICS

Aims

- To develop a spirit of inquisition in the student.
- To initiate students to use meaningful thought to solve different kinds of mathematical problems and to understand the basic structure of mathematics.
- To improve the point of view of the students on mathematics as per modern age requirement.
- To orient students towards various applications of Mathematics.
- To improve retention of mathematical concepts in the student.
- To make the learning process of Mathematics in a student-friendly approach.

Objectives

- To improve the scope for individual participation in the process of learning of Mathematics.
- To provide a vibrant and more alive learning process of Mathematics, so that math-phobia can be gradually reduced amongst students.
- To incorporate authentic learning based on analytical thinking on Mathematics.
- To promote problem oriented and discovery learning of mathematics.
- To help the student to build interest and confidence in learning the subject.

Proposed Scheme for Choice Based Credit System in B.Sc. with Mathematics

Semester	Core Course (12)	Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Course (SEC) (4)	Discipline Specific Elective (DSE) (6)
1	DSC1A- Differential Calculus	AECC1		
	DSC-2A Other than Mathematics			
	DSC-3A Other than Mathematics			
2	DSC-1B Differential Equations	AECC1		
	DSC-2B Other than Mathematics			
	DSC-3B Other than Mathematics			
3	DSC-1C Real Analysis		SEC 1	
	DSC-2C Other than Mathematics			
	DSC-3C Other than Mathematics			
4	DSC-1D Algebra		SEC2	
	DSC-2D Other than Mathematics			
	DSC-3D Other than Mathematics			
5			SEC3	DSE 1A
				DSE 2A
				DSE 3A
6			SEC4	DSE 1B
				DSE 2B
				DSE 3B

- For choosing subjects of DSE, GE, SEC students are hereby directed to consult with the respective College /Department.

Choices for Discipline Specific Elective (DSE)

Discipline Specific Elective–1A (Choose one)	Discipline Specific Elective–1B (Choose one)
DSE 1A. (a): Linear Algebra	**DSE 1B. (a):** Numerical Methods
DSE 1A. (b): Matrices	**DSE 1B. (b):** Complex Analysis
DSE 1A. (c): Mechanics	**DSE 1B. (c):** Linear Programming

Choices for Skill Enhancement Course (SEC)

Skill Enhancement Course–1 (Choose one)	Skill Enhancement Course–2 (Choose one)	Skill Enhancement Course–3 (Choose one)	Skill Enhancement Course–4 (Choose one)
SEC 1(a): Integral Calculus	**SEC 2(a):** Vector Calculus	**SEC 3(a):** Probability and Statistics	**SEC 4(a):** Graph Theory
SEC 1(b): Logic and Sets	**SEC 2(b):** Theory of Equations	**SEC 3(b):** Mathematical Finance	**SEC 4(b):** Boolean Algebra
SEC 1(c): Analytical Geometry	**SEC 2(c):** Number Theory	**SEC 3(c):** Mathematical Modelling	**SEC 4(c):** Transportation and Game Theory

Details of Courses under B.Sc. with Mathematics

			Credits		
Course Type		Description	Total Papers	Theory + Practical	Theory*+Tutorial
I Core Courses		4 paper from each 3 of choice	12	12*4 =48 12*2 =24	12*5 =60 12*1=12
II Elective Courses		2 papers from each discipline of choice	6	6*4=24 6*2=12	6*5=30 6*1=6
III Ability Enhancement Courses	**Compulsory**	**(Envs., English/ MIL)**	2	2*2=4	2*2=4
	Skill Enhancement Courses	(Skill Based)	4	4*2=8	4*2=8
Totals			24	120	120

Syllabuses of core subjects:

DSC-1A: Differential Calculus

Objectives: This course will help students to understand limit, continuity, differentiability and partial differentiation. They will also learn Rolle's theorem, mean value theorems, maxima and minima, indeterminate forms and different applications of calculus.

Limit and Continuity (ε and δ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem, Partial differentiation, Euler's theorem on homogeneous functions.

Tangents and normals, Curvature, Asymptotes, Envelope, Singular points, Tracing of curves. Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates.

Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of $sin\, x$, $cos\, x$, e^x, $log(l+x)$, $(l+x)^m$, Maxima and Minima, Indeterminate forms.

Books Recommended

1. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2002.

2. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2007.

DSC – 1B: Differential Equations

Objectives: The basics of ordinary and partial differential equations have been introduced in this course. Various methods to find the solutions of ordinary and partial differential equations and the classification of second order partial differential equation shall be discussed.

First order exact differential equations. Integrating factors, rules to find an integrating factor. First order higher degree equations solvable for x, y, p. Methods for solving higher-order differential equations. Basic theory of linear differential equations, Wronskian, and its properties. Solving a differential equation by reducing its order.

Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation, Simultaneous differential equations, Total differential equations.

Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial

differential equation of first order, Lagrange's method, Charpit's method.

Classification of second order partial differential equations into elliptic, parabolic and hyperbolic through illustrations only.

Books Recommended

1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.

2. I. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 1967.

DSC – 1C: Real Analysis

Objectives: Students will be able to understand about sets in R, sequences, series of functions and infinite series etc in this course.

Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, suprema and infima, completeness property of R, Archimedean property of R, intervals. Concept of cluster points and statement of Bolzano-Weierstrass theorem.

Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences. Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof).

Infinite series. Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p-series, Root test, Ratio test, alternating series, Leibnitz's test (Tests of Convergence without proof). Definition and examples of absolute and conditional convergence.

Sequences and series of functions, Pointwise and uniform convergence. M_n-test, M-test, Statements of the results about uniform convergence and integrability and differentiability of functions, Power series and radius of convergence.

Books Recommended

1. T. M. Apostol, *Calculus* (Vol. I), John Wiley and Sons (Asia) P. Ltd., 2002.

2. R.G. Bartle and D. R Sherbert, *Introduction to Real Analysis*, John Wiley and Sons (Asia) P. Ltd., 2000.

3. E. Fischer, *Intermediate Real Analysis*, Springer Verlag, 1983.

4. K.A. Ross, *Elementary Analysis- The Theory of Calculus Series*- Undergraduate Texts in Mathematics, Springer Verlag, 2003.

DSC – 1D: Algebra

Objectives: Basic concepts of different types of groups, rings and field shall be discussed through a large number of examples in this course.

Definition and examples of groups, examples of abelian and non-abelian groups, the group Z_n of integers under addition modulo n and the group U(n) of units under multiplication modulo n. Cyclic groups from number systems, complex roots of unity, circle group, the general linear group GL_n (n,R), groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle, (iii) a rectangle, and (iv) a square, the permutation group Sym (n), Group of quaternions. Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange's theorem, order of an element, Normal subgroups: their definition, examples, and characterizations, Quotient groups.

Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Z_n the ring of integers modulo n, ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields: Z_p, Q, R, and C. Field of rational functions.

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002**.**

2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.

3. Joseph A Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa, 1999.

4. George E Andrews, *Number Theory*, Hindustan Publishing Corporation, 1984.

Syllabuses of Discipline Specific Elective (DSE) subjects:

DSE 1A. (a) Linear Algebra

Objectives: Students shall learn basic concepts of vector spaces, basis, linear transformations, eigen values and eigen vectors etc in this course of study .

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Dual Space, Dual Basis, Double Dual, Eigen values and Eigen vectors, Characteristic Polynomial.

Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

Books Recommended

1. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra,* 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.

2. David C. Lay, *Linear Algebra and its Applications,* 3rd Ed., Pearson Education Asia, Indian

DSE 1A. (b) Matrices

Objectives: A thorough discussion on matrices has been introduced in this course. Students shall also learn different examples of matrices from Geometry, Physics, Chemistry, Combinatorics and Statistics.

R, R_2, R_3 as vector spaces over R. Standard basis for each of them. Concept of Linear Independence and examples of different bases. Subspaces of R_2, R_3.

Translation, Dilation, Rotation, Reflection in a point, line and plane. Matrix form of basic geometric transformations. Interpretation of eigen values and eigen vectors for such transformations and eigen spaces as invariant subspaces.

Types of matrices. Rank of a matrix. Invariance of rank under elementary transformations. Reduction to normal form, Solutions of linear homogeneous and non-homogeneous equations with number of equations and unknowns upto four.

Matrices in diagonal form. Reduction to diagonal form upto matrices of order 3. Computation of matrix inverses using elementary row operations. Rank of matrix. Solutions of a system of linear equations using matrices. Illustrative examples of above concepts from Geometry, Physics, Chemistry, Combinatorics and Statistics.

Books Recommended

1. A.I. Kostrikin, *Introduction to Algebra*, Springer Verlag, 1984.

2. S. H. Friedberg, A. L. Insel and L. E. Spence, *Linear Algebra*, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.

3. Richard Bronson, Theory and Problems of Matrix Operations, Tata McGraw Hill, 1989.

DSE 1A. (c) Mechanics

Objectives: Students shall learn basic concepts of mechanics with examples and applications of real world problems in this course.

Conditions of equilibrium of a particle and of coplanar forces acting on a rigid Body, Laws of friction, Problems of equilibrium under forces including friction, Centre of gravity, Work and potential energy. Velocity and acceleration of a particle along a curve: radial and transverse components (plane curve), tangential and normal components (space curve), Newton's Laws of motion, Simple harmonic motion, Simple Pendulum, Projectile Motion.

Books Recommended

1. A.S. Ramsay, *Statics*, CBS Publishers and Distributors (Indian Reprint), 1998.

2. A.P. Roberts, *Statics and Dynamics with Background in Mathematics*, Cambridge University Press, 2003.

3. S. Lang, *Introduction to Linear Algebra*, 2nd Ed., Springer, 2005.

4. Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007.

DSE 1B. (a) Numerical Methods

Objectives: This course will help students to understand various methods to find a root of an equation, solution of a system of linear equations, interpolation, numerical differentiation and integration etc.

Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method, LU decomposition, Gauss-Jacobi, Gauss-Siedel and SOR iterative methods.

Lagrange and Newton interpolation: linear and higher order, finite difference operators.

Numerical differentiation: forward difference, backward difference and central Difference.

Integration: trapezoidal rule, Simpson's rule, Euler's method.

Recommended Books

1. B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.

2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 5th Ed., New age International Publisher, India, 2007.

DSE 1B. (b) Complex Analysis

Objectives: Students shall understand the functions of complex variables, continuity, differentiability and elementary transformation concepts in complex variable. They will also know about complex Integral functions with Cauchy's Theorem, power series expansions of Taylor's and Laurant's series.

Limits, Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.

Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy-Goursat theorem, Cauchy integral formula.

Liouville's theorem and the fundamental theorem of algebra. Convergence of sequences and series, Taylor series and its examples.

Laurent series and its examples, absolute and uniform convergence of power series.

Books Recommended

1. James Ward Brown and Ruel V. Churchill, *Complex Variables and Applications,* 8th Ed., McGraw – Hill International Edition, 2009.

2. Joseph Bak and Donald J. Newman, *Complex analysis,* 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.

DSE 1B. (c) Linear Programming

Objectives: In this course, the students will be able to learn about various optimization techniques pertaining to linear programming and apply linear programming to problems arising out of real life problems.

Linear Programming Problems, Graphical Approach for Solving some Linear Programs. Convex Sets, Supporting and Separating Hyperplanes. Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method, Big-M method and their comparison.

Duality, formulation of the dual problem, primal- dual relationships.

Recommended Books

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear programming and Network*

Flows, 2nd Ed., John Wiley and Sons, India, 2004.

2. F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research,* 8th Ed., Tata McGraw Hill, Singapore, 2004.

3. Hamdy A. Taha, *Operations Research, An Introduction,* 8th Ed., Prentice-Hall India, 2006.

Syllabuses of Skill Enhancement Course (SEC):

SEC 1. (a) Integral Calculus

Objectives: The students will be able to learn the different integration techniques, reduction formulae and to calculate the surface area and volume of various solids of revolution.

Integration by Partial fractions, integration of rational and irrational functions. Properties of definite integrals. Reduction formulae for integrals of rational, trigonometric, exponential and logarithmic functions and of their combinations.

Areas and lengths of curves in the plane, volumes and surfaces of solids of revolution. Double and Triple integrals.

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.

2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd., 2002.

SEC 1. (b) Logic and Sets

Objectives: In this course of study, students will learn about different propositions of logic, truth table, logical operators, various operations and relations related to sets.

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, bi-conditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences.

Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

Sets, subsets, Set operations, the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation.

Book Recommended

1. R.P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson Education, 1998.

2. P.R. Halmos, *Naive Set Theory*, Springer, 1974.

3. E. Kamke, *Theory of Sets*, Dover Publishers, 1950.

SEC 1. (c) Analytical Geometry

Objectives: This course enables students to sketch and classify the different conics and conicoids. This helps students to solve problems arising from two and three dimensional geometry.

Techniques for sketching parabola, ellipse and hyperbola. Reflection properties of parabola, ellipse and hyperbola. Classification of quadratic equations representing lines, parabola, ellipse and hyperbola. Spheres, Cylindrical surfaces. Illustrations of graphing standard quadric surfaces like cone, ellipsoid.

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.

2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) Pvt. Ltd., 2002.

3. S.L. Loney, *The Elements of Coordinate Geometry*, McMillan and Company, London.

4. R.J.T. Bill, *Elementary Treatise on Coordinate Geometry of Three Dimensions*, McMillan India Ltd., 1994.

SEC 2. (a) Vector Calculus

Objectives: In this course, vector calculus has been introduced. Student will learn differentiation, partial differentiation, gradient, divergence and curl of a vector function. They will also learn different operations on two vectors.

Differentiation and partial differentiation of a vector function. Derivative of sum, dot product and cross product of two vectors.

Gradient, divergence and curl.

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.

2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd. 2002.

3. P.C. Matthew's, *Vector Calculus*, Springer Verlag London Limited, 1998.

SEC 2. (b) Theory of Equations

Objectives: This course enables students to learn general properties of polynomials, relation between the roots and the coefficients of equations, solutions of reciprocal, binomial, cubic and bi-quadratic equations Symmetric functions and it's applications have also been discussed.

General properties of polynomials, Graphical representation of a polynomials, maximum and minimum values of a polynomials, General properties of equations, Descarte's rule of signs positive and negative rule, Relation between the roots and the coefficients of equations. Symmetric functions of the roots and it's applications, Transformation of equations. Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic and bi-quadratic. Properties of the derived functions.

Books Recommended

1. W.S. Burnside and A.W. Panton, *The Theory of Equations*, Dublin University Press, 1954.

2. C. C. MacDuffee, *Theory of Equations*, John Wiley & Sons Inc., 1954.

SEC 2. (c) Number Theory

Objectives: Students will learn about number theory at UG level here. The topic like Lame's theorem, linear Diophantine equation, congruences, Goldbach conjecture, Euler's phi-function etc are key features of this course.

Division algorithm, Lame's theorem, linear Diophantine equation, fundamental theorem of arithmetic, prime counting function, statement of prime number theorem, Goldbach conjecture, binary and decimal representation of integers, linear congruences, complete set of residues. Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Möbius inversion formula, the greatest integer function, Euler's phi-function.

Books Recommended:

1. David M. Burton, *Elementary Number Theory* 6th Ed., Tata McGraw-Hill Edition, Indian reprint, 2007.

2. Richard E. Klima, Neil Sigmon, Ernest Stitzinger, *Applications of Abstract Algebra with Maple*, CRC Press, Boca Raton, 2000.

3. Neville Robinns, *Beginning Number Theory*, 2nd Ed., Narosa Publishing House Pvt. Limited, Delhi, 2007.

SEC 3. (a) Probability and Statistics

Objectives: In this course students will know about basic concepts on probability and statistics. Various probability distributions and their applications, mathematical expectation, moments etc. have been discussed.

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, continuous distributions: uniform, normal, exponential.

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables.

Books Recommended:

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.

2. Irwin Miller and Marylees Miller, John E. Freund, *Mathematical Statistics with Application*, 7th Ed., Pearson Education, Asia, 2006.

3. Sheldon Ross, *Introduction to Probability Model*, 9th Ed., Academic Press, Indian Reprint, 2007.

SEC 3. (b) Mathematical Finance

Objectives: Students will able to learn basic principles of mathematical finance in this course of study. Time value of money, inflation, net present value, portfolio return, Markowitz model etc are the key features of this course.

Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR. Bonds, bond prices and yields. Floating-rate bonds, immunization. Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints).

Books Recommended:

1. David G. Luenberger, *Investment Science*, Oxford University Press, Delhi, 1998.

2. John C. Hull, Options, *Futures and Other Derivatives*, 6th Ed., Prentice-Hall India, Indian reprint, 2006.

3. Sheldon Ross, *An Elementary Introduction to Mathematical Finance*, 2nd Ed., Cambridge University Press, USA, 2003.

SEC 3. (c) Mathematical Modelling

Objectives: Different applications of differential equations has been introduced for better understanding of the students to solve real life problem.

Applications of differential equations: the vibrations of a mass on a spring, mixture problem, free damped motion, forced motion, resonance phenomena, electric circuit problem, mechanics of simultaneous differential equations.

Applications to Traffic Flow. Vibrating string, vibrating membrane, conduction of heat in solids, gravitational potential, conservation laws.

Books Recommended:

1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.

2. I. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 1967.

SEC 4. (a) Graph Theory

Objectives: Basic concepts of graphs, Eulerian circuits, Hamiltonian cycles theorem etc. has been introduced in this course. Also, students shall learn the applications of graph theory.

Definition, examples and basic properties of graphs, pseudographs, complete graphs, bi-partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Books Recommended:

1. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory* 2nd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2003.

2. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

SEC 4. (b) Boolean Algebra

Objectives: Preliminary idea about Boolean algebra and its implementation to modern day computers have been discussed here.

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, maximal and minimal elements, lattices as ordered sets, complete lattices, lattices as algebraic structures, sublattices, products and homomorphisms.

Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials.

Karnaugh diagrams, switching circuits and applications of switching circuits.

Books Recommended:

1. B A. Davey and H. A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge, 1990.

2. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

SEC 4. (c) Transportation and Game Theory

Objectives: In this course the students will be able to learn about various transportation problems and the basic concepts of game theory through a problem solving approach.

Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure.

Books Recommended:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows*, 2nd Ed., John Wiley and Sons, India, 2004.

2. F. S. Hillier and G. J. Lieberman, *Introduction to Operations Research*, 9th Ed., Tata McGraw Hill, Singapore, 2009.

3. Hamdy A. Taha, *Operations Research, An Introduction*, 8th Ed., Prentice-Hall India, 2006.