Draft Undergraduate Syllabus
B. Sc. (non-Honours)
with Mathematics

Under

Dibrugarh University

(To be effective from session 2019-20)

As approved in the BoS meetings held on 30/11/2016, 10/03/2017 and 08/03/2019

Choice Based Credit System in B.Sc. with Mathematics

Semester	Core Course (12 Credits)	Ability Enhancement Compulsory Course (AECC) (2 Credits)	Skill Enhancement Course (SEC) (2 Credits)	Discipline Specific Elective (DSE) (6 Credits)
I	**DSC-1A (6C)** **Differential Calculus**	**AECC-1** Communicative English (2C)		
	DSC-2A(6C)	**AECC-2** Communicative Hindi/MIL/ Alternative English (2C)		
	DSC-3A(6C)			
II	**DSC-1B(6C)** **Differential Equations**	**AECC-3** Environmental Science/ Studies (2C)		
	DSC-2B(6C)			
	DSC-3B(6C)			
III	**DSC-IC** **Real Analysis**		**SEC-1.1**(2C)	
	DSC-2C(6C)			
	DSC-3C(6C)			
IV	**DSC-1D(6C)** **Algebra**		**SEC-2.1**(2C)	
	DSC-2D(6C)			
	DSC-3D(6C)			
V			**SEC-1.2**(2C)	**DSE-1A(6C)**
				DSE-2A(6C)
				DSE-3A(6C)
VI			**SEC-2.2**(2C)	**DSE-1B(6C)**
				DSE-2B(6C)
				DSE-3B(6C)

Discipline Specific Electives (DSE)

DSE-1A (choose one)

1. Matrices
2. Mechanics
3. Linear Algebra

DSE-1B (choose one)

1. Numerical Methods
2. Complex Analysis
3. Linear Programming

Skill Enhancement Course (SEC)

SEC 1 (choose one)

1. Logic and Sets
2. Analytical Geometry
3. Integral Calculus

SEC 2 (choose one)

1. Vector Calculus
2. Theory of Equations
3. Number Theory

SEC 3 (choose one)

1. Probability and Statistics
2. Portfolio Optimization
3. Mathematical Modeling

SEC 4 (choose one)

1. Boolean Algebra
2. Transportation and Game Theory
3. Graph Theory

Details of Courses under B.Sc. with Mathematics

Course	*Credits	
	Theory + Practical	Theory + Tutorials
I.Core Course (12 Papers)	12×4 = 48	12×5 = 60
Four Courses from each of the three disciplines of choice		
Core Course Practical / Tutorial*	12×2 = 24	12×1 = 12
(12 Practical/ Tutorials*) Four Courses from each of the three Disciplines of choice		
II. Discipline Elective Course **(6 Courses)**	6×4 = 24	6×5 = 30
Two papers from each discipline of choice including paper of interdisciplinary nature.		
Discipline Elective Course Practical / **(6 Practical / Tutorials*)**	6×2 = 12	6×1 = 6
Two Courses from each discipline of choice including paper of interdisciplinary		

• Optional Dissertation or project work in place of one Discipline elective paper (6 credits) in 6th Semester

III. Ability Enhancement Courses		
1. **Ability Enhancement Compulsory** Environmental Science/ English/MIL (3 Papers of 2 credits each)	2×3 = 6	2×2 = 4
2. Skill Enhancement Course **(Skill Based) (4 Papers of 2 credits each)**	4×2 = 8	**4×2 = 8**
	Total credit = 122	**Total credit = 122**

Institute should evolve a system/ policy about ECA/ General Interest/ Hobby/ Sports/ NCC/ NSS/ related courses on its own.
***wherever there is practical there will be no tutorials and vice –versa.**

DSC-1A: Differential Calculus

Total Marks: 100, Theory: 80, IA: 20,
Credit: 5+1=6;
(L=5, P=0, T=1)

Objectives: After going through this course the students should be able to

- differentiate functions
- find tangent, normal, curvature, asymptotes etc., of a given curve.

Unit-1 Marks: 25, Contact hrs: 30

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

Unit-2 Marks: 25, Contact hrs: 30

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

Unit-3 Marks: 30, Contact hrs: 30

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

Total Marks: 100, Theory: 80, IA: 20,

Credit: 5+1=6;

(L=5, P=0, T=1)

Objectives: After going through this course the students will be able to use various methods to solve differential equations

Unit-1 Marks: 30, Contact hrs: 30

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.

Unit-2 Marks: 20, Contact hrs: 20

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.

Unit-3 Marks: 20, Contact hrs: 20

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.

Unit-4 Marks: 10, Contact hrs: 20

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

DSC-1C: Real Analysis

Total Marks: 100, Theory: 80, IA: 20,

Credit: 5+1=6;

(L=5, P=0, T=1)

Objectives: After going through this course the students will be able to

- Analyse the properties of the Real line
- Describe various analytical properties of the real number system.

Unit-1 Marks: 20, Contact hrs: 20

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.

Unit-2 Marks: 20, Contact hrs: 20

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).

Unit-3 Marks: 20, Contact hrs: 20

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.

Unit-4 Marks: 20, Contact hrs: 30

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

Total Marks: 100, Theory: 80, IA: 20,
Credit: 5+1=6;
(L=5, P=0, T=1)

Objectives:: After going through this course the students will be able to

- Describe various algebraic structures on sets;
- Identify the algebraic structures present in different branches of Sciences.

Unit-1 Marks: 20, Contact hrs: 30

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 symmetric groups, Group of quaternions.

Unit-2 Marks: 30, Contact hrs: 30

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.

Unit-3 Marks: 30, Contact hrs: 30

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: $\mathbb{Z}_p, \mathbb{Q}, \mathbb{R}$ and $\mathbb{C}$. 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.

DSE-1A.1: Matrices

Total Marks: 100, Theory: 80, IA: 20,
Credit: 5+1=6;
(L=5, P=0, T=1)

Objectives:: After going through this course the students will be able to

- Discuss vector spaces, bases, rank of matrix
- Find solution of linear equations using matrices.

Unit-1 Marks: 10, Contact hrs: 15

$\mathbb{R}, \mathbb{R}^2, \mathbb{R}^3$ as vector spaces over $\mathbb{R}$. Standard basis for each of them. Concept of Linear Independence and examples of different bases. Subspaces of $\mathbb{R}^2, \mathbb{R}^3$.

Unit-2 Marks: 20, Contact hrs: 15

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.

Unit-3 Marks: 20, Contact hrs: 30

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.

Unit-4 Marks: 30, Contact hrs: 30

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.2: Mechanics

Total Marks: 100, Theory: 80, IA: 20,
Credit: 5+1=6;
(L=5, P=0, T=1)

Objectives : After going through this course the students will be able to

- Describe the moment of a force and couple, general equation of equilibrium
- Solve problems of centre of gravity, simple harmonic motion.

Unit-1 Marks: 16, Contact hrs: 20
Conditions of equilibrium of a particle and of coplanar forces acting on a rigid Body,

Unit-2 Marks: 16, Contact hrs: 20
Laws of friction, Problems of equilibrium under forces including friction,

Unit-3 Marks: 16, Contact hrs: 15
Centre of gravity, Work and potential energy.

Unit-4 Marks: 16, Contact hrs: 15
Velocity and acceleration of a particle along a curve: radial and transverse components (plane curve), tangential and normal components (space curve),

Unit-5 Marks: 16, Contact hrs: 20
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.

DSE 1A.3: Linear Algebra

Total Marks: 100, Theory: 80, IA: 20,

Credit: 5+1=6;

(L=5, P=0, T=1)

Objectives:: After going through this course the students will be able to

- Discuss vector space, subspace;
- Define Basis and explain their properties.

Unit-1 Marks: 20, Contact hrs: 30

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

Unit-2 Marks: 20, Contact hrs: 20

Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations.

Unit-3 Marks: 20, Contact hrs: 20

Dual Space, Dual Basis, Double Dual, Eigen values and Eigen vectors, Characteristic Polynomial.

Unit-4 Marks: 20, Contact hrs: 20

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 Reprint, 2007.
3. S. Lang, *Introduction to Linear Algebra,* 2nd Ed., Springer, 2005.
4. Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007.

DSE 1B.1: Numerical Methods

Total Marks: 100, Theory: 80, IA: 20,

Credit: 5+1=6;

(L=5, P=0, T=1)

Objectives: After going through this course the students will be able to

- Apply the numerical methods and interpolation formulae in solving algebraic equations;
- Solve differential equation using Numerical techniques.

Unit-1 Marks: 40, Contact hrs: 45

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.

Unit-1 Marks: 40, Contact hrs: 45

linear and higher order Lagrange and Newton interpolation:, finite difference operators. Numerical differentiation: forward difference, backward difference and central Difference.

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

Books Recommended

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.2: Complex Analysis

Total Marks: 100, Theory: 80, IA: 20,
Credit: 5+1=6;
(L=5, P=0, T=1)

Objectives: After going through this course the students will be able to

- Define analytic function
- Describe complex number system, its differentiation and integration.

Unit-1 Marks: 25, Contact hrs: 30

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.

Unit-2 Marks: 30, Contact hrs: 20

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.

Unit-3 Marks: 15, Contact hrs: 20

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

Unit-4 Marks: 10, Contact hrs: 20

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.3: Linear Programming

Total Marks: 100, Theory: 80, IA: 20,

Credit: 5+1=6;

(L=5, P=0, T=1)

Objectives: After going through this course the students will be able to

- describe various optimization techniques pertaining to linear programming
- apply linear programming to problems arising out of real life problems.

Unit-1 Marks: 20, Contact hrs: 20

Linear Programming Problems, Graphical Approach for Solving some Linear Programs. Convex Sets, Supporting and Separating Hyperplanes.

Unit-2 Marks: 20, Contact hrs: 20

Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables,

Unit-3 Marks: 20, Contact hrs: 20

Two-phase method, Big-M method and their comparison.

Unit-4 Marks: 20, Contact hrs: 30

Duality, formulation of the dual problem, primal- dual relationships, economic interpretation of the dual, sensitivity analysis.

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,* 8th Ed., Tata McGraw Hill, Singapore, 2004.
3. Hamdy A. Taha, *Operations Research, An Introduction,* 8th Ed., Prentice-Hall India, 2006.

SEC 1.1: Logic and Sets

Total Marks: 50, Theory: 40, IA: 10,
Credit: 2;
(L=2, P=0, T=0)

Objectives: After going through this course the students will be able to

- list the truth and falsity of a logical statement
- Differentiate between a logical statement and an ordinary statement
- Define and describe various properties of sets.

Unit-1 Marks: 20, Contact hrs:10

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional 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.

Unit-2 Marks: 10, Contact hrs: 10

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.

Unit-3 Marks: 10, Contact hrs: 10

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.

Books 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 1.2: Analytical Geometry

Total Marks: 50, Theory: 40, IA: 10,
Credit: 2;
(L=2, P=0, T=0)

Objectives: After going through this course the students will be able to

- Sketch parabola, ellipse and hyperbola
- Solve various geometrical problems analytically.

Unit-1 Marks: 20, Contact hrs:15

Techniques for sketching parabola, ellipse and hyperbola. Reflection properties of parabola, ellipse and hyperbola.

Unit-2 Marks: 20, Contact hrs:15

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 1.3: Integral Calculus

Total Marks: 50, Theory: 40, IA: 10,
Credit: 2;
(L=2, P=0, T=0)

Objectives: After going through this course the students will be able to

- Learn properties of definite integral, reduction formulae
- Find areas, lengths, volume etc by using integration.

Unit-1 Marks: 20, Contact hrs:15

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.

Unit-2 Marks: 20, Contact hrs:15

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 2.1: Vector Calculus

Total Marks: 50, Theory: 40, IA: 10,

Credit: 2;

(L=2, P=0, T=0)

Objectives: After going through this course the students will be able to

- Evaluate differentiation of vector functions
- Determine gradient, divergence and curl of differentiable functions.

Unit-1 Marks: 20, Contact hrs:15

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

Unit-2 Marks: 20, Contact hrs:15

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 2.2: Theory of Equations

Total Marks: 50, Theory: 40, IA: 10,

Credit: 2;

(L=2, P=0, T=0)

Objectives: After going through this course the students will be able to discuss various properties of algebraic equations, symmetric properties of roots and determination of roots.

Unit-1 Marks: 20, Contact hrs:15

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.

Unit-2 Marks: 20, Contact hrs:15

Symmetric functions, Applications symmetric function of the roots, Transformation of equations. Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic and biquadratic. 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 2.3: Number Theory

Total Marks: 50, Theory: 40, IA: 10,
Credit: 2;
(L=2, P=0, T=0)

Objectives: After going through this course the students will be able to

- obtain solutions of Diophantine equations
- define number theoretic functions

Unit-1 Marks: 20, Contact hrs:15

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.

Unit-2 Marks: 20, Contact hrs:15

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 3.1: Probability and Statistics

Total Marks: 50, Theory: 40, IA: 10,
Credit: 2;
(L=2, P=0, T=0)

Objectives: After going through this course the students will be able to

- Characterize the statistical techniques.
- Describe the mathematical theory of probability

Unit-1 Marks: 20, Contact hrs:15

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.

Unit-2 Marks: 20, Contact hrs:15

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 3.2: Portfolio Optimization

Total Marks: 50, Theory: 40, IA: 10,
Credit: 2;
(L=2, P=0, T=0)

Objectives: After going through this course the students will be able to define portfolio optimization and apply them to real world problems

Unit-1 Marks: 10, Contact hrs:10

Financial markets. Investment objectives. Measures of return and risk. Types of risks.

Unit-2 Marks: 20, Contact hrs:10

Portfolio of assets. Expected risk and return of portfolio. Diversification. Mean-variance portfolio optimization- the Markowitz model and the two-fund theorem, risk-free assets and one fund theorem, efficient frontier.

Unit-3 Marks: 10, Contact hrs:10

Portfolio performance evaluation measures.

Books Recommended

1. F.K. Reilly, Keith C. Brown, *Investment Analysis and Portfolio Management*, 10th Ed., South-Western Publishers, 2011.
2. H.M. Markowitz, *Mean-Variance Analysis in Portfolio Choice and Capital Markets*, Blackwell, New York, 1987.
3. D.G. Luenberger, *Investment Science*, 2nd Ed., Oxford University Press, 2013.

SEC 3.3: Mathematical Modeling

Total Marks: 50, Theory:40, IA: 10,

Credit: 2;

(L=2, P=0, T=0)

Objectives:: After going through this course the students will be able to solve differential equations and linear programming problems used in mathematical modelling

Unit-1 Marks: 20, Contact hrs:15

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.

Unit-2 Marks: 20, Contact hrs:15

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 4.1: Boolean Algebra

Total Marks: 50, Theory: 40, IA: 10,
Credit: 2;
(L=2, P=0, T=0)

Objectives: After going through this course the students will be able to

- define lattice
- identify various lattice properties and apply them to describe switching circuits.

Unit-1 Marks: 20, Contact hrs:15

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.

Unit-2 Marks: 20, Contact hrs:15

Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials, Quinn-McCluskey method, 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 4.2: Transportation and Game Theory

Total Marks: 50, Theory: 40, IA: 10,

Credit: 2;

(L=2, P=0, T=0)

Objectives: After going through this course the students will be able to

- model the transportation problem mathematically
- describe the conflicts among rational agents using game theory.

Unit-1 Marks: 20, Contact hrs:15

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.

Unit-2 Marks: 20, Contact hrs:15

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.

SEC 4.3: Graph Theory

Total Marks: 50, Theory: 40, IA: 10,

Credit: 2;

(L=2, P=0, T=0)

Objectives: Students will be introduced to the fundamentals of Graph Theory and different representations of a Graph for practical applications.

Unit-1 Marks: 20, Contact hrs:15

Definition, examples and basic properties of graphs, pseudographs, complete graphs, bi-partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles,

Unit-2 Marks: 20, Contact hrs:15

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.