Proposed Scheme for Choice Based Credit System in

B.Sc (Hons.) Mathematics

Semester	Core Course (14)	AECC (2)	SEC (2)	DSE (4)	GE (4)
1	C1.1 Calculus	AECC 1			GE 1
	C1.2 Algebra				
2	C2.1 Real Analysis	AECC 2			GE 2
	C2.2 Differential Equations				
3	C3.1 Theory of Real Functions		SEC		GE 3
	C3.2 Group Theory I				
	C3.3 PDE & System of ODE				
4	C4.1 Numerical Methods		SEC		GE 4
	C4.2 Riemann Integration & Series of Functions				
	C4.3 Ring Theory & Linear Algebra I				
5	C5.1 Multivariate Calculus			DSE 1	
	C5.2 Mechanics I			DSE 2	
6	C6.1 Metric Spaces & Complex Analysis			DSE 3	
	C6.2 Higher Trigonometry & Linear Algebra II			DSE 4	

AECC -- Ability Enhancement Compulsory Course.
SEC -- Skill Enhancement Course.
DSE -- Discipline Specific Elective
GE -- Generic Elective

C1.1 Calculus

UNIT 1

Second and higher order derivatives. Use of partial fractions. Use of De Moivre's theorem. Leibnitz theorem. Differentiability and differentials. Rolle's theorem. Theorem of Darboux. Mean value theorem. Lagrange's and Cauchy's forms. Indeterminate forms. L'Hospital's rule.

UNIT 2

Taylor's theorem. Lagrange's. Cauchy's and generalized form of remainder. Taylor's infinite series. Maclaurin's theorem and infinite series. Maxima and minima. Applied problems.

UNIT 3

Reduction formulae for $\sin^n x$, $\cos^2 X$, sin mX $\cos^n X$, $\tan^n x$, $\cot^n x$, $\sec^n x$, $\operatorname{cosec}^n x$, cosm$x\sin^n x$, $1/(a+b\cos x)^n$, $1/(x^2+a^2)$n. Integration by special devices. Definition of a definite integral as the limit of a sum. Definite integral as an area. Geometric interpretation. Calculations, Primitives, Fundamental theorem of calculus. Summation of series. Properties of definite integral.

UNIT 4

Parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution. Techniques of sketching conics, reflection properties of conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics

UNIT 5

Recap of vectors preliminaries. Scalar triple product and vector triple product. Their geometrical meanings. Product of four vectors. Reciprocal system of vectors. Vectors function of a scalar variable. Limit and continuity Vector differentiation. Directional derivatives. Level surface. Tangent plane and normal to a level of surface. Gradient, divergence and curl.

Books Recommended

1. T.M. Apostol, Calculus I
2. T.M. Apostol, Calculus II
3. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education. Delhi, 2005.
4. M.J. Strauss, G.L. Bradley and K.J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2002
5. H. Anton, I. Bivens and S. Davis, *Calculus*, 7th Ed., John Willey and Sons (Asia) P. Ltd., Singapore, 2002.
6. R. Courant and F. John, Introduction to *Calculus and Analysis* (Volume I and II), Springer- Verlag, New York, Inc,1989.

C1.2 Algebra
UNIT 1

Equivalence relations, Functions, Composition of functions, Invertible of Functions, One to one correspondence and cardinality of a set, Well - ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm.

UNIT 2
Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

UNIT 3
Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear independence.

UNIT 4
Linear transformations, null space, range rank nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations.

UNIT 5
Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

Books recommended

1. S.Kumaresan, Linear Algebra- Geometric approach
2. Sen, Ghosh, Topics in Abstract Algebra
3. David C. Lay, *Linear Algebra and its Applications,* 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
4. A Textbook of Vector Analysis- Shanti Narayan and P.K. Mittal (S.Chand & Co)
References.

C2.1 Real Analysis

UNIT 1

Review of Algebraic and Order Properties of R, ε - neighbourhood of a point in R, Idea of countable sets, uncountable sets and uncountability of R. Bounded above sets, Bounded below sets, Bounded sets, Unbounded sets, Suprema and Infirma, The Completeness Property of R, The Archimedean Property, Density of Rational (and Irrational) numbers in R.

UNIT 2

Intervals. Limit points of a set, Isolated points, Illustrations of Bolzano - Weierstrass theorem for sets. Open and Closed sets Compact sets. Heine Borel theorem.

UNIT 3

Sequences, Bounded sequence, Convergent sequence, Limit of a sequence, Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequence, Divergence Criteria, Monotone Subsequence Theorem (statement only). Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion.

UNIT 4

Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

UNIT 5

Fourier Series, Preliminary and main theorem. Fourier series for odd and even functions. Half - range series. Definite integral as functions of a parameter. Uniform convergence of improper integrals. The test for uniform, convergence. Properties of uniformly convergent integrals.

Books recommended

1. R.G. Bartle and D.R. Sherbert*, Introduction to Real Analysis*, 3rd Ed., John Willey and Sons (Asia) Pvt. Ltd., Singapore, 2002.

2. Ajit Kumar and S. Kumaresan - *A basic course in real analysis*, CRC Press, 2014.

C2.2 Differential Equations

UNIT 1

Differential equations. General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form.

UNIT 2

Differential equations of the first order and first degree - Equation reducible to homogenous form. Bernonlli's equation. Exact differential equations. Differential equation of the first order but not of the first degree. Equations solvable for p, x, y. General and singular solutions. Clairaut's equation Linear differential equations of higher order with constant coefficients. Complementary function and particular integrals.

UNIT 3

General solutions of homogenous equation of second order, principle of super position for homogenous equation, Wronskian: its properties and applications. Linear homogenous and non - homogenous equations of higher order with constant coefficients.

UNIT 4

Linear equation of second order. Standard form. Complete solution. Complementary function. Particular integral. Reduction to normal form. Transformation by changing the independent variable. Method of variation of parameters. Solution by operators.

UNIT 5

Simultaneous equations of the form dx/P = dy/Q = dz/R. Solution. Geometrical interpretation. Total differential equations. Solution by inspection.

Books Recommended

1. Belinda Barnes and Glenn R. Fulford*, Mathematical Modeling with Case studies, A Differential Equation Approach using Maple and Matlab, 2nd Ed.,* Taylor and Francis group, London and New York, 2009.
2. C.H. Edwards and D.E. Penny*, Differential Equations and Boundary Value problems Computing and Modeling,* Pearson Education India, 2005.
3. S.L. Ross*, Differential Equations*, 3rd Ed., John Wiley and Sons, India, 2004.
4. Martha L. Abell, James P Braselton, *Differential Equations with MATHEMATICA*, 3rd Ed., Elsevier Academic Press, 2004.

C3.1 Theory of Real Functions

UNIT 1

Limits of functions (approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity. Algebra of continuous fractions.

UNIT 2

Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non - uniform continuity criteria, uniform continuity theorem.

UNIT 3

Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremum. Rolle's theorem, Mean value theorem, intermediate value property of derivatives.

UNIT 4

Darboux's theorem. Applications of mean value theorem to inequalities and approximation of polynomials, Taylor's theorem to inequalities Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder.

UNIT 5

Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, relative extrema. Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions, ln(1+x), 1/ax+b and (1+x)^n.

Books Recommended

1. R. Bartle and D.R. Sherbert*, Introduction to Real Analysis*, John Wiley and Sons,2003.
2. K.A. Ross, *Elementary Analysis: The Theory of Calculus*, Springer, 2004.
3. A. Mattuck, *Introduction to Analysis*, Prentice Hall, 1999.
4. S.R. Ghorpade and B.V. Limaye, *A Course in Calculus and Real Analysis*, Springer, 2006.

C3.2 Group Theory I

UNIT 1

Group. Definition. Examples. Abelian Group. Order of a group (types of group). Elementary properties of groups using definition. Integral power of an element of a group.

UNIT 2

Subgroups and examples of subgroups, Cosets, properties of cosets. Normal subgroups. Cyclic group, centralizer, normalizer, centre of a group, product of two subgroups.

UNIT 3

Properties of cyclic groups, classification of subgroups of cyclic groups. Cyclic notation for permutations, properties of permutations, even and odd permutations, alternating group.

UNIT 4

Lagrange's theorem and consequences including Fermat's Little theorem. Normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

UNIT 5

Group hormorphisms, properties hormorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorohism theorems.

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. I.N. Herstein, *Topics in Algebra*, Wiley Eastern Limited, India, 1975.
4. Sen, Ghosh and Mukherjee, *Topics in Abstract Algebra*.

C3.3 PDE and Systems of ODE

UNIT 1

Partial Differential Equations - Basic concepts and Definitions, Mathematical Problems. First - Order Equations: Classifications, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solutions of Quasi Linear Equations.

UNIT 2

Canonical Forms of First - order Linear Equations. Method of Separation of Variables for solving first order partial differential equations. Wave equation and Laplace equation. Classification of second order Linear Equations to canonical forms.

UNIT 3

The Cauchy Problem of an infinite string . Initial Boundary Value Problems, Semi - Infinite String with a fixed end, Semi - Infinite String with a Free end, Equations with non - homogenous boundary conditions.

UNIT 4

Non - Homogenous Wave Equation. Method of separation of variables. Solving the Vibrating String Problem. Solving the Heat Conduction problem Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients.

UNIT 5

Basic Theory of linear systems in normal form, homogenous linear systems with constant coefficients: Two Equations in two unknown functions, The method of successive approximations, the Euler method, the modified Euler method, The Runge - Kutta method.

Books Recommended

1. Tyn Myint - U and Lokenath Debnath, *Linear Partial Differential Equations for Scientists and Engineers*, 4th edition, Springer, Indian reprint, 2006

2. S.L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, India, 2004.

3. Martha L. Abell, James P. Braselton, *Differential equations* with *MATHEMATICA*, 3rd Ed., Elsevier Academic Press, 2004.

C4.1 Numerical Methods

Use of Scientific Calculator is allowed.

UNIT 1

Finite differences. The operators Δ, -- and E, Properties. Central difference operators μ and δ. Gauss's central difference formula.

UNIT 2

Transcendental and Polynomial equations. Bisection method, Newton's method. Secant method. Rate of convergence of these methods.

UNIT 3

System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis.

UNIT 4

Interpolation. Lagrange and Newton's methods. Error bounds. Gregory forward and backward difference interpolation.

UNIT 5

Numerical Integration: Trapezoidal rule, Simpson's $3/8^{th}$ rule, Boole's Rule. Midpoint rule, Composite Trapezoidal rule, Composite Simpson's rule.

Books Recommended

1. Brian 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*, 6^{th} Ed., New age International Publisher, India, 2007.
3. C.F. Gerald and P.O. Wheatley, *Applied Numerical Analysis*, Pearson Education, India, 2008.
4. *Finite Differences and Numerical Analysis* - H.C. Saxena (S Chand & Co).

C4.2 Riemann Integration and Series of Functions

UNIT 1

Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability. Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions; Riemann integrability of monotone and continuous functions.

UNIT 2

Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions. Intermediate Value theorem for Integrals; Fundamental theorems of Calculus. Integration by parts.

UNIT 3

Pointwise and uniform convergence of sequence of functions. Theorems or continuity , derivability and integrability of the limit function of a sequence if functions.

UNIT 4

Series of functions; Theorems on the continuity and derivability of the sum function of a series of a functions; Cauchy criterion for uniform convergence and Weierstrass M -Test.

UNIT 5

Limit superior and Limit inferior. Power series, radius of convergence, Cauchy Hadamard Theorem. Differentiation and integration of power series ; Abel's Theorem; Weierstrass Approximation Theorem.

Books Recommended

1. K.A. Ross, *Elementary Analysis*, *The Theory of Calculus*, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
2. R.G. Bartle, D.R. Sherbert, *Introduction to Real Analysis*, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
3. T.M. Apostol - Analysis .

C4.3 Ring Theory and Linear Algebra I

UNIT I

Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring. Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.

UNIT 2

Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I,II and III, field of quotients.

UNIT 3

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

UNIT 4

Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Isomorphisms, Isomorphism theorems, invertibility and isomorphisms.

UNIT 5

Rank. Row and column rank. Linear equations. Homogenous and non - homogenous. Minimum polynomial. Characteristic vector and root. Characteristic polynomial. Cayley Hamilton theorem.

Books Recommended

1. Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007.
2. S. Kmaresan, *Linear Algebra - A Geometric Approach*, Prentice Hall of India, 1999.
3. I.N. Herstein, *Topics in Algebra.*
4. Sen, Ghosh. *Topics in Abstract Algebra*.

C5.1 Multivariate Calculus

UNIT 1

Functions of several variables, limit and continuity of functions of two variables. Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes.

UNIT 2

Extrema of functions of two variables, method of Langrange multipliers, constrained optimization problems. Definition of vector field, divergence and curl.

UNIT 3

Double integration over rectangular region, double integration over non- rectangular region, Double integrals in polar co-ordinates, Triple integrals, Triple integral over a parallelpiped and solid regions. Volume by triple integrals, cylindrical and spherical co-ordinates.

UNIT 4

Change of variables in double integrals and triple integrals. Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path.

UNIT 5

Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem. The Divergence theorem.

Books Recommended

1. G.B. Thomas and R.L. Finley, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K.J. Smith*, Calculus,* 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2005.
3. E. Marsden, A.J. Tromba and A. Wienstein, *Basic Multivariable Calculu*s, Springer (SIE), Indian reprint, 2005.
4. James Stewart, *Multivariable Calculus, Concepts and Contexts*, 2nd Ed., Brooks/Cole, Thomson Learning, USA, 2001.
5. T.M. Apostol, *Calculus II.*
6. T.M. Apostol*, Mathematical Analysis.*

C5.2 Mechanics I

UNIT 1

Coplanar forces. Moment of a system of coplanar forces. Equation of line of action of the resultant of a system of coplanar forces. Necessary and sufficient condition for the equilibrium of a system of coplanar forces acting on a rigid body. Astatic equilibrium. Equilibrium of a rigid body under three forces. (m,n) theorem.

UNIT 2

Work. Work done by a system of concurrent forces. Virtual work. Principle of virtual work for a system of coplanar forces acting on a particle. Omission of forces. Stability of equilibrium. Stable, unstable and neutral equilibrium. Work function test for the nature of stability of equilibrium. Energy test for equilibrium.

UNIT 3

Centre of gravity. Definition and general formulation. Centre of gravity of arc, plane area, area bounded by curve, solid of revolution, surface of revolution. Centre of gravity bounded area in polar coordinates. The theorem of Pappus, Friction, Statical, dynamical and limiting friction. Laws of friction. Limiting equilibrium. Coefficient of Friction. Angle of friction. Cone of friction. Equilibrium of a body on a rough inclined plane.

UNIT 4

Fundamental definitions and principles. Motion in a straight line. Simple harmonic motion. Motion under earth's attraction. Uniplanar motion where the accelerations parallel to fixed axes are given. Composition of simple harmonic motion.

UNIT 5

Tangential and normal accelerations. Constrained motion. Conservation of energy. The simple pendulum. Motion on a rough curve. Motion in a resisting medium. Motion where the mass moving varies.

Books Recommend

1 Statics - Md Motihur Rahman (New Central Book Agency, Kolkata)
2. Dynamics - P.N. Chatterjee.

C6.1 Metric Spaces and Complex Analysis

UNIT 1

Metric spaces: definition and examples. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set,. Subspaces.

UNIT 2

Sequences in metric spaces, Cauchy sequences. Complete Metric Spaces. Convergence in a metric space, dense sets. Limits, Limits involving the point at infinity, continuity.

UNIIT 3

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 4

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 5

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. S. Kumaresan, *Topology of Metric Spaces*, 2nd Ed., Narosa Publishing House, 2011.
2. G.F. Simmons*, Introduction to Topology and Modern Analysis*, McGraw-Hill, 2004.
3. Ponnuswasmy, *Complex Analysis*.
4. *Complex Variables and Applications* - R.V. Churchill & J.W. Brown (McGraw- Hill)
5. *Complex Analysis* - J.N. Sharma.

C6.2 Higher Trigonometry and Linear Algebra II

UNIT 1

De Moivre's Theorem. Statement. Proof of De Moivre's theorem for integral indices. Alternative method. Proof for rational indices. All possible values of $(\cos x + i \sin x)_{p/q.}$ Application of De Moivre's theorem for integral and fractional indices. Expansion of sin nx, cos nx, in series of sinx, cosx and tanx.

UNIT 2

Exponential, sine, cosine, and logarithms of a complex number. Definitions. Logarithmic, exponential and hyperbolic functions. Inverse functions - trigonometric and hyperbolic functions. Laws of logarithmic. Summation of series.

UNIT 3

Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators.

UNIT 4

Eigen spaces of a linear operator, diagonalizability, invariant subspaces and Cayley-Hamilton theorem theorem, the minimal polynomial for a linear operator.

UNIT 5

Inner product spaces and norms, Gram - Schmidt orthogonalisation process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator, minimal solutions to systems of linear equations, Normal and self-adjoint operators.

Books Recommended

1. *Higher Algebra* - Ghosh & Maity (New Central Book Agency, Kolkata)
2. *Trigonometry* - Mazumdar & Dasgupta.
3.M. Artin, *Abstract Algebra, 2nd Ed.,* Pearson, 2011.
4. S. Kumaresan*, Linear Algebra - A Geometric Approach, Prentice Hall of India, 1999*.

DSE 1.1 Number Theory

UNIT 1

Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues.

UNIT 2

Chinese Remainder theorem. Fermat's Little theorem. Wilson's theorem. Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product.

UNIT 3

The Mobius Inversion formula, the greatest integer function, Euler's phi-function. Euler's theorem, reduced set of residues, some properties of Euler's phi-function.

UNIT 4

Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties.

UNIT 5

Quadritic Residues. Quadratic reciprocity, quadratic congruences with composite moduli. The Jacobi symbol. Greatest integer function. Arithmetic functions.

Books Recommended

1. David M. Burton, *Elementary Number Theory, 6th Ed.,* Tata McGraw-Hill, Indian reprint, 2007.
2. Neville Robbins, *Beginning Number Theory, 2nd Ed*., Narosa Publishing House Pvt. Ltd., Delhi, 2007.
3. Ajay Kr. Chaudhuri, *An Introduction to Number Theory (*New Central Book Agency, Kolkata)

DSE 1.2 Analytic Geometry

UNIT 1

General equation of the 2nd degree. Chord of the contact. Pole and Polar. Conjugate points. Chord in terms of its middle point. Diameter. Conjugate diameter. Intersection of two conics. Conics through the points of intersection of two given conics.

UNIT 2

Pair of tangents. Director circle. Asymptotes. Polar equation of a conic. Derivatives of polar equation of a conic.

UNIT 3

Sphere. Equation. Section of a sphere by a plane. Equation of a circle in space. Intersection of two spheres. A sphere passing through a circle. Tangent and tangent plane to a sphere.

UNIT 4

Cone. Equation of a cone with its vertex at the origin. Right circular cone. Right circular cone. Tangent plane to a cone. Reciprocal cone. Three mutually perpendicular generators.

UNIT 5

Cylinder Equation. Right circular cylinder.

Books Recommended

1. B. Das, *Analytic Geometry* (Orient Book Company)
2. S.L. Loney, *The Elements of Coordinate Geometry*, McMillan and Company, London.

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

DSE 2.1 Boolean Algebra and Automata Theory

UNIT 1

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sublattices, products and homoorphisms.

UNIT 2

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.

UNIT 3

Introduction: Alphabets, strings, and languages. Finite Automata and Regular Languages: deterministic and non-deterministic finite automata, regular expressions, regular languages and their relationship with finite automata, pumping lemma and closure properties of regular languages.

UNIT 4

Context Free Grammars and Pushdown Automata: Context free grammars (CFG), Parse trees, ambiguities in grammars and languages, pushdown automaton (PDA) and the language accepted by PDA, Non-deterministic PDA, properties of context free languages; normal forms, pumping lemma, closure properties, decision properties.

UNIT 5

Turing Machines: Turing machine as a model of computation, programming with a Turing machine, variants of Turing machine and their equivalence. Undecidability: Recursively enumerable and recursive languages, undecidable properties about Turing machines: halting problem, Post Correspondence Problem, and undecidability problems about CFGs.

Books Recommended

1. B.A. Davey and H.A. Priestly, *Introduction to Lattices and Order*, Cambridg University Press, Cambridge, 1990.
2. Edgar G. Goodaire and Michael M. Parameter, *Discrete Mathematics with Graph Theory, (2nd Ed.),* Pearson Education (Singapore) P. Ltd., Indian Reprint, 2003.
3. Rudolf Lidl and Gunter Pilz, *Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.*
4. J.E. Hopcroft, R. Motwani and J.D. Ullman, *Introduction to Automata Theory, Languages and Computation, 2nd Ed., Addison-Wesley, 2001.*
5. H.R. Lewis, C.H. Papadimitriou, *Elements of the Theory of Computation, 2nd Ed*., Prentice-Hall, NJ,1997.
6. J.A. Anderson, *Automata Theory with Modern Applications*, Cambridge University Press, 2006.

DSE 2.2 Probability and Statistics

UNIT 1

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.

UNIT 2

Discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential. Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional functions.

UNIT 3

Expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution.

UNIT 4

Correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables.

UNIT 5

Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with finite variance.

Books Recommended

1. Robert B. 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 Applications*, 7th Ed., Pearson Education, Asia, 2006.
3. Sheldon Ross, *Introduction to Probability Models*, 9th Ed., Academic Press, Indian Reprint, 2007.
4. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, *Introduction to the Theory of Statistics, 3rd Ed*., Tata McGraw-Hill, Reprint, 2007.

DSE 3.1 Theory of Equations

UNIT 1

General properties of polynomials. Graphical representation of a polynomial, maximum and minimum values of a polynomial. General properties of equations, positive and negative rule. Relation between the roots and coefficients of equations.

UNIT 2

Symmetric functions. Applications of symmetric function of the roots. Transformation of equations.

UNIT 3

Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic and biquadratic. Cardan's method of solution of cubic equations.

UNIT 4

Symmetric functions of the roots. Newton's theorem on the sums of powers of roots, homogenous products. Descarte's rule of signs.

UNIT 5

Separation of the roots of equations. Strums theorem, Applications of Strum's theorem. Conditions for reality of the roots of an equation and biquadratic. Solutions of numerical equations.

Books Recommended

1. W.S. Burnside and A.W. Panton, *The Theory of Equations, Dublin University Press, 1954*.
2.C.C. MacDufee, *Theory of Equations*, John Wiley & Sons Inc., 1954.
3. *Higher Algebra* - Ghosh & Maity (New Central Book Agency, Kolkata).

DSE 3.2 Linear Programming

UNIT 1

Introduction to linear programming problem, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format.

UNIT 2

Introduction to artificial variables, two - phase method, Big-M method and their comparison. Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.

UNIT 3

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

UNIT 4

Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

UNIT 5

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

Books Recommended

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows*, 2nd Ed., John Wile & 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. Tata, *Operations Research, An Introduction, 8th Ed*., Prentice-Hall India, 2006.
4. G. Hadley, *Linear Programmin*g. Narosa Publishing House, New Delhi,2002.

DSE 4.1 Mechanics II

UNIT 1

Moment and product of inertia. Momental ellipsoid. Principal axes, D'Alembert's principle. The general equations of motion. Independence of the motions of translation and rotation. Impulsive forces.

UNIT 2

Motion of a fixed axis. Moment of momentum. The compound pendulum. Reactions of the axis of rotation. Motion about a fixed axis (impulsive forces). Centre of percussion.

UNIT 3

Motion in two dimensions (Finite forces). Kinetic energy in two dimensions. Moment of momentum in two dimensions. Varying mass.

UNIT 4

Laws of Coulomb friction, application to simple and complex surface contact friction problems, transmission of power through belts, screw jack, wedge, first moment of an area and the centroid, other centres, Theorems of Pappus-Guldinus.

UNIT 5

Conservative force field, conservation for mechanical energy, work energy equation, kinetic energy and work kinetic energy expression based on centre of mass, moment of momentum equation for a single particle and a system of particles.

Books Recommended

1. *A Textbook of Hydrostatics* - Ray and Sharma (S Chand)
2. *Rigid Dynamics* - Md Motihur Rahman (New Central Book Agency, Kolkata)
3. I.H. Shames and G. Krishna Mohan Rao, *Engineering Mechanics: Statics and Dynamics, (4th Ed.)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.
4. R.C. Hibbeler and Ashok Gupta, *Engineering Mechanics: Statics and Dynamics, 11th Ed.*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi.

DSE 4.2 Differential Geometry

UNIT 1

Space curve. Tangent. Arc length. Order of contact between curve and surface. Fundamental planes (osculating, normal and rectifying plane). Curvature. Torsion. Serret-Frenent formula. Direction cosines of the principal normal and binomial.

UNIT 2

Osculating circle. Osculating sphere. Involute. Evolute. Surface. Regular points and singularities on a surface. Curvilinear equation of the curve on the surface. Parametric curves. Tangent plane and normal and their Cartesian equation.

UNIT 3

Family of surface. Envelope. The edge of regression. Ruled surface. Developable surface. Necessary and sufficient condition that any surface represents a developable surface. Theorems related to developable surfaces. Developable associated with space curve. Theorems and questions on osculating developables. Polar developables. Rectifying developables.

UNIT 4

First fundamental form and its geometrical interpretation and properties. Second fundamental form and geometrical interpretation. Weingarton equations (derivative of N). Direction coefficients. Direction ratios. Differential equations of family of curves. Orthogonal trajectories. Condition for orthogonalities.

UNIT 5

Normal curvature (curvature of normal section). Mensnier's theorem. Principal direction. Principal curvature. First curvature. Mean curvature. Gaussian curvature. Minimal surface. Necessary and sufficient condition for a surface to developable. Lines of curvature. Rodrique's formula. Lines of curvature as parametric curves. Euler's theorem.

Books Recommended

1. *Differential Geometry of Three Dimensions*, C.E. Weatherbum (Radha Publishing House, Kolkata)
2. *Differential Geometry: An Integral Approach*, Nirmala Prakash (Tata McGraw Hill)

SEC 1.1 Logic and Sets

UNIT 1

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators

UNIT 2

Prepositional equivalence: Logical equivalences, Predicates and quantifiers: Introduction, Quantifiers, Binding Variables and Negations.

UNIT 3

Sets, subsets, Set operations and 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 4

Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections.

UNIT 5

Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations.

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 Set*s, Dover Publishers, 1950.

SEC 1.1 Computer Graphics

UNIT 1

Development of computer graphics: Raster Scan and Random Scan graphics storages, displays processors and character generators.

UNIT 2

Colour display techniques, interactive input/output devices. Points, lines and curves.

UNIT 3

Scan conversion, line-drawing algorithms, circle and ellipse generation, conic-section generation.

UNIT 4

Polygon filling anti aliasing. Two-dimensional viewing.

UNIT 5

Coordinate systems, linear transformations, line and polygon clipping algorithms.

Books Recommended

1. D. Hearn and M.P. Baker, *Computer Graphics, 2nd Ed.*, Prentice-Hall of India,2004.

2. J.D. Voley, Avan Dam, S.K. Feiner and J.F. Hughes, *Computer Graphics*: *Principals and Practices*, 2nd Ed., Addison-Wesley, MA, 1990 .

3. D.F. Rogers, *Procedural Elements in Computer Graphics, 2nd Ed*., McGraw Hill Book Company, 2001.

4. D.F. Rogers and A.J. Admas, *Mathematical Elements in Computer Graphics, 2nd Ed*., McGraw Hill Book Company, 1990

SEC 2.1 Graph Theory

UNIT 1

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs.

UNIT 2

Sub graphs-matrices-connectedness, walks, trials and paths, connectedness and components.

UNIT 3

Isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph.

UNIT 4

Trees: characterization of trees, centre of trees.

UNIT 5

Travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Books Recommended

1. S. Arumugam and S. Ramachandran, *Invitation to graph theory*, Scitech Publications, 2005.
2. B.A. Davey and H.A. Priestly, *Introduction to Lattices and Orde*r, Cambridge University Press, Cambridge, 1990.
3. Edgar G. Goodaire and Michael M. Parameter, *Discrete Mathematics with Graph Theory, 2nd Edition*, Pearson Education (Singapore) P. Ltd., Indian reprint, 2003.
4. Rudolf Lidl and Gunter Pilz, *Applied Abstract Algebra, 2nd Ed.,* Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

SEC 2.2 Operating Systems: Linux

UNIT 1

Linux: The Operating System: Linux history, Linux features, Linux distributions, Linux's relationship to Unix, Overview to Linux Architecture.

UNIT 2

Installation, Start up scripts, system processes(an overview), Linux Security, The Ext2 and Ext3. File systems: General characteristics of, The Ext3 File system, file permissions.

UNIT 3

Use Management: Types of Users, the powers of Root, managing users (adding and deleting): using the command line and GUI tools.

UNIT 4

Resource Management in Linux: file and directory management, system calls for files. Process Management.

UNIT 5

Signals, IPC: Pipes, FIFQs, System V IPC, Message Queues, system calls for processes, Memory Management, library and system calls for memory.

Books Recommended

1. Arnold Robbins, Linux Programming by Examples *The Fundamentals*, 2nd Ed., Pearson Education, 2008.
2. Cox K, Red Hat *Linux Administrator's Guide*, PHI, 2009.
3. R. Stevens, *UNIX Network Programming*, 3rd Ed., PHI, 2008.
4. Sumitabha Das, *Unix Concepts and Applications, 4th Ed*., TMH, 2009.
5. Ellen Siever, Stephen Figgins, Robert Love, Arnold Robbins, *Linux in a Nutshell*, 6th Ed., O'Reilly Media, 2009.
6. Neil Mathew, Richard Stones, Alax Cox, *Beginning Linux Programming*, 3rd Ed., 2004.

GE 1.1 Object Oriented Programming in C++

UNIT 1

OOP Paradigm. Comparison of Programming paradigms. Characteristics of Object-Oriented Programming Languages. Object-based programming languages C++: Brief History of C++, Structure of a C++ program.

UNIT 2

Difference between C and C++ - cin, cout, new, delete operators, ANSI/ISO Standard C++, Comments, Working with Variables and const Qualifiers Enumeration, Arrays and Pointer.

UNIT 3

Implementing oops concepts in C++ Objects, Classes, Encapsulation, Data Abstraction, Inheritance, Polymorphism, Dynamic Binding, Message Passing, Default Parameter Value, Using Reference variables with Functions.

UNIT 4

Abstract data types, Class Component, Object & Class, Constructors Default and Copy Constructor, Assignment operator deep and shallow coping, Access modifiers - private, public and protected. Implementing Class Functions within Class declaration or outside the Class declaration, instantiation of objects.

UNIT 5

Scope resolution operator , Working with Friend Functions, Using Static Class members. Understanding Compile Time Polymorphism function overloading Rules of Operator Overloading (Unary and Binary) as member function/friend function, Implementation of operator overloading of Arithmetic Operators.

Practical to be performed in lab.

Books Recommended

1. A.R. Venugopal, Rajkumar, and T. Ravishanker, *Mastering* C++, TMH, 1997.
2. S.B. Lippman and J. Lajoie, C++ Primer, 3rd Ed., Addison Wesley, 2000.
3. Bruce Eckel, *Thinking in C++,* 2nd Ed., President, Mindview Inc., Prentice Hall.
4. D. Parasons, *Object Oriented Programming with C++,* BPB Publication.
5. Bjame Stroustrup, *The C++ Programming Language*, 3rd Ed., Addison Wesley.

GE 1.2 Calculus

UNIT 1

Real variables. Continuous and discrete. Interval. Function. Domain of definition. Monotone functions. Inverse functions. Geometrical representations. Limit of a function on the real line. One-sided limits-right hand and left hand limits. Different types of limits. Theorems on limits.

UNIT 2

Continuous functions. Definitions. Discontinuous functions. Theorems. Properties. Uniform continuity (definition only).

UNIT 3

Derivatives. Definition. Continuity of a derivable function. Algebraic and transcendental functions. General rules of differentiation. Function of a function. Chain rule. Inverse function. Logarithmic differentiation. Implicit functions. Parametric equations.

UNIT 4

Derivative of a rate measure. Time rate of change. Rectilinear motion. Related rates. Geometric interpretation. Meaning of the sign of the derivative. Determination of multiple roots.

UNIT 5

Basic methods of integration. Integration of substitution. Integrations by parts. Integration of trigonometric and hyperbolic functions. Rational function of sine and cosine.

Books Recommended

1. Differential Calculus - Ghoshy and Maity (New Central Book Agency, Kolkata)
2. Integral Calculus - Ghosh and Maity (New Central Book Agency, Kolkata)

GE 2.1 Finite Element Methods

UNIT 1

Introduction to finite element methods, comparison with finite difference methods, Methods of weighted residuals, collocations, least squares.

UNIT 2

Galerkin's method. Variational formulation of boundary value problems equivalence of Galerkin and Ritz methods.

UNIT 3

Applications to solving simple problems of ordinary differential equations. Linear, quadratic and higher order elements in one dimensional and assembly, solutions of assembled system.

UNIT 4

Simplex element in two and three dimensions, quadratic triangular elements, rectangular elements, serendipity elements and isoperimetric elements and their assembly, discretization with curved boundaries.

UNIT 5

Interpolation functions, numerical integration, and modelling considerations. Solution of two dimensional partial differential equation under different Geometric conditions.

Books Recommended

1. J.N. Reddy, *Introduction to Finite Element Methods*, Tata McGraw- Hill, 2003.
2. K.J. Bathe, *Finite Element Procedures*, Prentice-Hall, 2001
3. R.D. Cook, D.S. Malkus and M.E Plesha, *Concepts and Applications of Finite Element Analysis*, John Wiley and Sons, 2002.
4. Thomas J.R. Hughes, The Finite Element Method: *Linear Static and Dynamic Finite Element Analysis,* Dover Publications, 2000.
5. George R. Buchanan, *Finite Element Analysis*, McGraw Hill, 1994.

GE 2.2 Econometrics

UNIT 1

Statistical Concepts Normal distribution; chi-square, t and F-distributions; estimation of parameters; properties of estimators; testing of hypotheses: defining statistical hypotheses; distribution of test statics; testing hypotheses related to population parameters: Type I and Type II errors; power of a test; tests for comparing parameters from two samples.

UNIT 2

Simple Linear Regression Model: Two Variable Case Estimation of model by method of ordinary least squares; properties of estimators; goodness of fit; testes of hypotheses; scaling and units measurement; confidence intervals; Gauss-Markov theorem; forecasting.

UNIT 3

Multiple Linear Regression Model Estimation of parameters, properties of OLS estimators; goodness of fit - R2 and adjusted R2; partial regression coefficients; testing hypotheses - individual and joint; functional form of regression models; qualitative (dummy) independent variables.

UNIT 4

Violations of Classical Assumption: Consequences, Detections and Remedies Multicollinearity; heteroscedasticity; serial correlation.

UNIT 5

Specification Analysis Omission of a relevant variable; inclusion of irrelevant variable; testes of specification errors.

Books Recommended

1. Jay L. Devore, *Probability and Statics for Engineers*, Cengage Learning, 2010.
2. John E. Freund, *Mathematical Statics*, Prentice Hall, 1992.
3. Richard J. Larsen and Morris L. Marx, *An Introduction to Mathematical Statistics and its Applications, Prentice Hall, 2011.*
4. D.N. Gujarati and D.C. Porter, *Essentials of Econometrics*, McGraw Hill, 4th Ed., International Edition, 2009.
5. Christopher Dougherty, *Introduction to Econometric*s, Oxford University Press, 3rd Rd., Indian Edition, 2007.

GE 3.1 Applications of Algebra

UNIT 1

Coding Theory: introduction to error correcting codes ,linear codes, generator and parity check matrices, minimum distance, Hamming Codes, decoding and cyclic codes.

UNIT 2

Matrices of real numbers. Operations on matrices. The transpose of a matrix. Properties of transposes. Special types of matrices. Rank of a matrix. Its determination. Determination of rank by considering minors. Determinations by rank by elementary transformations. Consistency and solution of system of linear equations with not more than three variables.

UNIT 3

Special types of matrices: idempotent, nilpotent, involution, and projection tri diagonal matrices, circulant matrices, Vandermonde matrices, Hadamard matrices, permutation and doubly stochastic matrices, Positive Semi-definite matrices: positive semi-definite matrices, square root of appositive semi-definite matrix, a pair of positive semi-definite matrices, and their simultaneous diagonallization.

UNIT 4

Symmetric matrices and quadratic matrices: diagonalization of symmetric matrices, quadratic forms, constrained optimization, singular value decomposition, and application to image processing and statistics.

UNIT 5

Applications of linear transformations: Fibonacci numbers, incidence models, and differential equations. Least squares method: Approximate solutions of system of linear equations, approximate inverse of an m x n matrix, solving a matrix equation using its normal equation.

Books Recommended

1. L.N. Herstein and D.J. Winter, *Primer on Linear Algebra*, Macmillan Publishing Company, New York, 1990.
2. S.R. Nagpaul and S.K. Jain, *Topics in Applied Abstract Algebra*, Thomson Books and Cole, Belmont, 2005.
3. Richard E. Kilma, Neil Sigmon, Ernest Stitzinger, *Application of Abstract Algebra with Maple*, CRC Press LLC, Boca Raton,2000.
4. David C. Lay, *Linear Algebra and its Applications*, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
5. Fuzhen Zhang, *Matrix theory*, Springer-Verlag New York, Inc., New York, 1999.

GE 3.2 Information Security

UNIT 1

Overview of Security: Protection versus security; aspects of security-data integrity, data availability, privacy; security problems, user authentication, Orange Book.

UNIT 2

Security Threats: Program threats, worms, viruses, Trojan horse, trap door, stack and buffer over flow; system threats-intruders; communication threats- tapping and piracy.

UNIT 3

Cryptography: Substitution, transposition ciphers, symmetric-key algorithms-Data Encryption Standard, advanced encryption standards, public key encryption - RSA; Diffie-Hellman key exchange, ECC cryptography, Message Authentication - MCA, hash functions.

UNIT 4

Digital signatures: Symmetric key signatures, public key signatures, message digests, public key infrastructures.

UNIT 5

Security Mechanisms: Intrusion detection, auditing and logging, tripwire, system-call monitoring.

Books Recommended

1. W. Stalllings, *Cryptography and Network Security Principles and Practices*, 4th Ed., Prentice-Hall of India, 2006.
2. C. Pfleeger and S.L. Pfleeger, *Security in Computing*, 3rd Ed., Prentice-Hall of India, 2007.
3. D. Gollmann, *Computer Security*, John Wiley and Sons, NY, 2002.
4. J. Piwprzyk, T. Hardjono and J. Seberry, *Fundamentals of Computer Security*, Springer-Verlag, Berlin, 2003.
5. J.M. Kizza, *Computer Network Security*, Springer,2007.
6. M. Merkow and J. Breithaupt, *Information Security: Principles and Practices*, Pearson Education, 2006.

GE 4.1 Cryptography and Network Security

UNIT 1

Public Key Cryptography Principles & Applications, Algorithms: RSA, Message Authentication: One way Hash Functions: Message, Digest, MD5, SHA1. Public Key Infrastructure.

UNIT 2

Digital Signatures. Digital Certificates, Certificate Authorities. Network Attacks: Buffer Overflow, IP Spoofing, TCP Session Hijacking, Sequence Guessing, Network Scanning: ICMP, TCP sweeps, Basic Port Scans.

UNIT 3

Denial of Service Attacks: SYN Flood, Teardrop attacks, land, Smurf Attacks. IP security Architecture: Overview, Authentication header, Encapsulating Security Pay Load, combining Security Associations, Key Management.

UNIT 4

Virtual Private Network Technology: Tunneling using IPSEC, Requirements, Secure Socket Layer, and Secure Electronic Transactions, Network Management Security: Overview of SNMP Architecture - SNMPV1, SNMPV3.

UNIT 5

Firewall Characteristics & Design Principles. Types of Firewalls: Packet Filtering Router, Application Level Gateway or Proxy, Content Filters, Bastion Host.

Books Recommended

1. W. Stallings, *Networks Security Essentials: Application & Standards*, Pearson Education, 2000
2. TCP/IP Protocol Suite, Behrouz A. Forouzan*, Data Communication and Networking*, Tata McGraw Hill.
3. W. Stallings, *Cryptography and Network Security, principles and Practice,* Pearson Education, 2000.

GE 4.2 Combinatorial Mathematics

UNIT 1

Basic counting principles, Permutations and Combinations (with and without repetitions). Binomial theorem, Multinomial theorem, Counting subsets, Set-partitions, Stirling numbers.

UNIT 2

Generating functions: Algebra of formal power series, Generating function models, Calculating generating functions, Exponential generating functions.

UNIT 3

Recurrence relations: Recurrence relation models, Divide and conquer relations, Solution of recurrence relations, Solutions by generating functions.

UNIT 4

Integer partitions, System of distinct representatives. Polya theory of counting: Necklace problem and Burnside's lemma, Cyclic index of a permutation group, Polya's theorems and their immediate applications.

UNIT 5

Latin squares, Hadamard matrices, Combinatorial designs*: t* designs, BIBDs, Symmetric designs.

Books Recommended

1. J.H. Van Lint and R.M. Wilson, *A Course in Combinatorics,* 2nd Ed., Cambridge University Press, 2001.
2. V. Krishnamurthy, *Combinatorics, Theory and Application,* Affiliated East-West Press, 1985.
3. P.J. Cameron, *Combinatorics, Topics, Techniques, Algorithms,* Cambridge University Press, 1995.
4. M. Jr. Hall, *Combinatorial Theory,* 2nd Ed., John Wiley & Sons, 1986.
5. S.S. Sane, *Combinatorial Techniques,* Hindustan Book Agency, 2013.
6. R.A. Brauldi, *Introductory Combinatorics,* 5th Ed., Pearson Education Inc., 2009.