

Proposed Scheme for Choice Based Credit System in

B.Sc with Mathematics

Semester	Core Course (12)	AECC (2)	SEC (4)	DSE (6)
1	C1A Calculus	AECC 1		
	C2A			
	C3A			
2	C1B Real Analysis	AECC 2		
	C2B			
	C3B			
3	C1C Group Theory I		SEC1	
	C2C			
	C3C			
4	C1D Differential Equations		SEC2	
	C2D			
	C3D			
5			SEC3	DSE1A
				DSE2A
				DSE3A
6			SEC4	DSE1B
				DSE2B
				DSE3B

C -- Course Course

AECC -- Ability Enhancement Compulsory Course

SEC -- Skill Enhancement Course

DSE -- Discipline Specific Elective

DSE1A (choose one)

1. Analytic Geometry
2. Number Theory

DSE1B (choose one)

1. Theory of equations
2. Linear Programming

SEC1 (choose one)

1. Logic and Sets
2. Computer Graphics

SEC2 (choose one)

1. Graph Theory
2. Linear algebra I

SEC3 (choose one)

1. Probability and Statistics
2. Mechanics I

SEC4 (choose one)

1. Mechanics II
2. Complex Analysis

C1A Calculus

UNIT 1

Second and higher order derivatives. Use of partial fractions. 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 $\sin^n x$, $\cos^2 X$, $\sin mX \cos^n X$, $\tan^n x$, $\cot^n x$, $\sec^n x$, $\operatorname{cosec}^n x$, $\cos m x \sin^n x$, $1/(a+b \cos x)^n$, $1/(x^2+a^2)^n$. 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

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.

C1B 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 Infima, 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.

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.

C1C 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. Properties of cyclic groups, classification of subgroups of cyclic groups.

UNIT 3

Permutations. Cyclic notation for permutations, properties of permutations, even and odd permutations, alternating group. Lagrange's theorem and consequences including Fermat's Little theorem. Normal subgroups, factor groups.

UNIT 4

Group homomorphisms, properties homomorphisms, properties of isomorphisms, First, Second and Third isomorphism theorems. Cayley's theorem, Cauchy's theorem for finite abelian groups.

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*.

C1D 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. 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.
5. George F. Simmons, *Differential Equations with Applications and Historical Notes*, McGraw Hill Education, 2017

DSE1A 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. 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.

DSE1A 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. Quadratic 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).

DSE1B 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. 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. MacDuffee, *Theory of Equations*, John Wiley & Sons Inc., 1954.
3. *Higher Algebra* - Ghosh & Maity (New Central Book Agency, Kolkata).

DSE1B 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-corer 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. 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 Programming*. Narosa Publishing House, New Delhi, 2002.

SEC1 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

Propositional 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. 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 Sets*, Dover Publishers, 1950.

SEC1 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. 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

SEC2 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, trails 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. 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 Order*, 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.

SEC2 Linear Algebra I

UNIT 1

Rank. Row and column rank. Linear equations. Homogenous and non – homogenous. Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

UNIT 2

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. 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*, John wiley & Sons, 2006.
4. Sen, Ghosh. *Topics in Abstract Algebra*, Universities Press, 2014.

SEC3 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. Expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution.

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.

SEC3 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.

Books Recommended

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

SEC4 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.

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.

SEC4 Complex Analysis

UNIT 1

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.

UNIT 2

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. Ponnuswamy, *Complex Analysis*.
2. *Complex Variables and Applications* - R.V. Churchill & J.W. Brown (McGraw- Hill)
3. *Complex Analysis* - J.N. Sharma.