

B.Sc. (Hons.) Mathematics Syllabus

CHOICE BASED CREDIT SYSTEM (CBCS)

S.C.S. (A) College, Puri



Academic Session

2015-18

CBCS - B.Sc. Mathematics (Hons.) Syllabus

B. SC. (HONOURS) - MATHEMATICS
+3 1st Year
SEMESTER – I
CORE COURSE – I

F.M. – 75 marks
End Sem. – 60 marks
Internal – 15 marks

Time – 3hrs

Theory

UNIT – I

Hyperbolic functions, higher order derivatives, Leibniz rule and its applications to problems of the type $e^{ax+b} \sin x$, $e^{ax+b} \cos x$, $(ax + b)^n \sin x$, $(ax + b)^n \cos x$, concavity and inflection points, Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin nx dx$, $\int \cos nx dx$, $\int \tan nx dx$, $\int \sec nx dx$, $\int (\log x)^n dx$, $\int \sin^n x \cos^n x dx$, Reduction formulae, LHospitals rule

UNIT – II

Curvature, Asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves.

UNIT – III

Quadrature, Volumes by slicing disks and washers methods, volumes by cylindrical shells, Parametric equations, Parametrizing a curve, arc length, arc length of parametric curves, area of surface of revolution.

UNIT – IV

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. Sphere, Cone, Cylinder, Central Conicoids.

UNIT – V

Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration.

Practical

Marks – 25 (Experiment – 12, Viva-voce – 08, Record – 05)

List of Practicals (Using any software) (Free hand Graph)
Practical/Lab work to be performed on a Computer.

1. Plotting the graphs of the functions e^{ax+b} , $\log(ax + b)$, $1/(ax + b)$, $\sin(ax + b)$, $\cos(ax + b)$, $|ax + b|$ and to illustrate the effect of a & b on the graph.
2. Plotting the graphs of the polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.
3. Sketching curves (Cardioids, asteroid, cissoids, catenary, cycloid folium of Descartes)
4. Tracing of conics (Ellipse, Parabola, Hyperbola)
5. Matrix operation (addition, multiplication, inverse, transpose).

Books Recommended:

1. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007. Chapters: 4 (4.3,4.4, 4.5 & 4.7), 9(9.4), 10(10.1-10.4).

2. H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002, Chapters: 6, (6.2-6.5),7(7.8), 8(8.2-8.3, Pages:532-538), 11(11.1), 13(13.5)
3. Analytical Geometry of Quadratic Surfaces, B. P. Acharya and D.C. Sahu, Kalyani Publishers, New Delhi, Ludhiana.

Books for Reference:

1. R. K. Panda and P. K. Satapathy, Topics in Calculus.
2. Shanhi Narayan on Vol – II, III.

C - 1.2

Algebra – I

Total Marks: 100 (Theory: 80 Marks + Mid - Sem: 20 Marks)
5 Lectures, 1 Tutorial (per week per student)

UNIT – I

Polar representation of complex numbers, n -th roots of unity, De Moivres theorem for rational indices and its applications.

UNIT – II

Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

UNIT – III

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 – IV

Introduction to linear transformations, Matrix of a linear transformation, Inverse of a matrix.

UNIT – V

Characterizations of invertible matrices, Subspaces of \mathbb{R}^n , dimension of subspaces of \mathbb{R}^n and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix.

Books Recommended:

1. T. Biswal, R. B. Dash and D. K. Dalai, A course on Complex Analysis, Kalyani Publisher.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005. Chapters: 2(2.4), 3, 4(4.1-4.1.6, 4.2-4.2.11, 4(4.1-4.4.8), 4.3-4.3.9, 5(5.1-5.1.4).
3. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007. Chapters:1(1.1-1.9), 2(2.1-2.3, 2.8, 2.9), 5(5.1,5.2)

GENERIC ELECTIVES/ INTERDISCIPLINARY

(Credit: 06 each, Marks – 100)

SEMESTER – I

GE – I

CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS

UNIT – I

Curvature, Asymptotes, Tracing of Curves (Cartenary, Cycloid, Folium of Descartes, Astroid, Limacon, Cissoid & loops), Rectification, Quadrature, Volume and Surface area of solid of revolution.

UNIT – II

Sphere, Cone and Cylinder, Conicoid.

UNIT – III

Explicit and Implicit functions, Limit and Continuity of functions of several variables, Partial derivatives, Partial derivatives of higher orders, Homogeneous functions, Change of variables, Mean value theorem, Taylors theorem and Maclaurins theorem for functions of two variables. Maxima and Minima of functions of two and three variables, Implicit functions, Lagranges multipliers, multiple integrals.

UNIT – IV

Ordinary Differential Equations of 1st order and 1st degree (Variables separable, homogenous, exact and linear), Equations of 1st order but higher degree.

UNIT – V

Second order linear equations with constant coefficients, homogeneous forms; Second order equations with variable coefficients, Variation of parameters, Laplace transforms and its applications to solutions of differential equations.

Books Recommended:

1. R. K. Panda and P. K. Satapathy, Topics in Calculus, S. G. Publications. Chapter – I, II, III, IV.
2. B. P. Acharya and D.C. Sahu – Analytical Geometry of Quadratic Surfaces, Kalyani Publishers, New Delhi, Ludhiana.
3. Santosh K. Sengar-Advanced Calculus, Chapters: 2, 4, 5, 6, 7, 11, 12,13.
4. J. Sinharoy and S. Padhy-A Course of Ordinary and Partial Differential Equations, Kalyani Pub- lishers. Chapters: 2(2.1 to 2.7), 3, 4(4.1 to 4.7), 5, 9(9.1, 9.2, 9.3, 9.4, 9.5, 9.10, 9.11, 9.13).

Books for References:

1. Santinarayan – Text Book of Calculus, Part II & III.

SEMESTER – II

C – 2.1

Real Analysis (Analysis – I)

**Total Marks: 100 (Theory: 80 Marks + Mid - Sem: 20 Mark
5 Lectures, 1 Tutorial (per week per student)**

UNIT – I

Review of Algebraic and Order Properties of \mathbb{R} , Neighborhood of a point in \mathbb{R} , Idea of countable sets, uncountable sets and uncountability of \mathbb{R} . Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima.

UNIT – II

The Completeness Property of \mathbb{R} , The Archimedean Property, Density of Rational (and Irrational) numbers in \mathbb{R} , Intervals. Limit points of a set, Isolated points, Illustrations of Bolzano-Weierstrass theorem for sets.

UNIT – III

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

UNIT – IV

Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's n -th root test, Integral test.

UNIT – V

Alternating series, Leibniz test, Absolute and Conditional convergence

Book Recommended:

1. G. Das and S. Pattanayak, Fundamentals of Mathematics Analysis, TMH Publishing Co., Chapters: 2(2.1 to 2.4, 2.6), 3(3.1-3.5), 4(4.1 to 4.7, 4.10, 4.11, 4.12, 4.13).

Books for References:

1. R. B. Dash & D. Dalai, A Course on Mathematical Analysis, Kalyani Publishers.
2. S. C. Mallick and S. Arora – mathematical Analysis.

C - 2.2

Differential Equations

Total Marks: 100 (Theory: 60 Marks + Mid - Sem: 15 Marks)
4 Lectures, (per week per student)

UNIT – I

Differential equations and mathematical models, First order and first degree ODE (variables separable, homogeneous, exact, and linear), Equations of first order but of higher degree, Applications of first order differential equations (Growth, Decay and Chemical Reactions, Heat flow, Oxygen debt, Economics).

UNIT – II

Second order linear equations (homogeneous and non-homogeneous) with constant coefficients, variation of parameters, method of undetermined coefficients.

UNIT – III

Equations reducible to linear equations with constant coefficients, Euler's equation. Applications of second order differential equations, second order equations with variable coefficients,

UNIT – IV

Power series solutions of second order differential equations.

UNIT – V

Laplace transforms and its applications to solutions of differential equations.

Part – II Practical

Marks – 25 (Experiment – 12, Viva-voce – 08, Record – 05)

List of Practicals (Using any Software)

Practical/Lab work to be performed on a Computer.

1. Plotting of second order solution of family of differential equations.
2. Plotting of third order solution of family of differential equations.
3. Growth model (exponential case only).
4. Decay model (exponential case only).
5. Oxygen debt model.
6. Economic model.
7. Vibration problems.

Book Recommended:

1. J. Sinha Roy and S. Padhy, A Course of Ordinary and Partial Differential Equations, Kalyani Publishers, New Delhi. Chapters: 1, 2(2.1 to 2.7), 3, 4(4.1 to 4.7), 5, 7(7.1-7.4), 9(9.1, 9.2, 9.3, 9.4, 9.5, 9.10, 9.11, 9.13).

Books for References:

1. Martin Braun, Differential Equations and their Applications, Springer International.
2. M.D. Raisinghania-Advanced Differential Equations, S. Chand & Company Ltd., New Delhi.

SEMESTER – II GE - II

LINEAR ALGEBRA AND ADVANCED ALGEBRA

UNIT – I

Vector space, Subspace, Span of a set, Linear dependence and Independence, Dimensions and Basis, Linear transformations, Range, Kernel, Rank, Nullity, Inverse of a linear map, Rank-Nullity theorem.

UNIT – II

Matrices and linear maps, Rank and Nullity of a matrix, Transpose of a matrix, Types of matrices, Elementary row operations, System of linear equations, Matrix inversion using row operations, Determinant and Rank of matrices, Eigen values, Eigen vectors, Quadratic forms.

UNIT – III

Group Theory: Definition and examples, Subgroups, Normal subgroups, Cyclic groups, Cosets, Quotient groups, Permutation groups, Homomorphism.

UNIT – IV

Ring Theory: Definition and examples, Some special classes of Rings, Ideals, Quotient rings, Ring homomorphism, Isomorphism theorems.

UNIT – V

Zero divisors, Integral domain, Finite fields, Finite field $\mathbb{Z}/p\mathbb{Z}$, Field of quotients of an Integral domain, Polynomial ring, Division algorithm, Remainder theorem, Factorization of polynomials, irreducible and reducible polynomials, Primitive polynomials, Irreducibility tests, Eisenstein Criterion.

Books Recommended:

1. V. Krishnamurty, V. P. Mainra, J. L. Arora-An introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd., New Delhi, Chapters: 3, 4(4.1 to 4.7), 5(except 5.3), 6(6.1, 6.2, 6.5, 6.6, 6.8), 7(7.4 only).
2. I. H. Seth, Abstract Algebra, Prentice Hall of India. (Ch.- 7,8,9,10,12,13,14,15,16,17,19,21)

Books for References:

1. I. N. Herstein, Topics in Algebra.

+3 2nd YEAR
SEMESTER – III
C – 3.1:

Theory of Real Functions (Analysis – II)

Total Marks: 100

(Theory: 80 Marks + Mid-Sem: 20 Marks)

UNIT – I

Limits of functions ($\epsilon - \delta$ 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.

UNIT – II

Algebra of continuous functions, 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 – III

Differentiability of a function at a point and in an interval, Caratheodorys theorem, algebra of differentiable functions, L-Hospital Rule.

UNIT – IV

Mean Value Theorem:

Relative extrema, interior extremum theorem, Rolles theorem, Mean value theorem, intermediate value property of derivatives, Darboux's theorem, Applications of mean value theorem to inequalities and approximation of polynomials.

UNIT – V

Higher derivatives and Taylors theorem with Lagranges form of remainder, Taylors theorem with Cauchys form of remainder, application of Taylors theorem to convex functions, relative extrema, Taylors series and Maclaurins series expansions of exponential and trigonometric functions,

$\ln(1+x)$, $1/(ax+b)$ and $(1+x)^n$.

Book Recommended:

1. G. Das and S. Pattanayak, Fundamentals of Mathematics Analysis, TMH Publishing Co., Chapters: 6(6.1-6.7, 6.9), 7(7.1-7.7),

Books for References:

1. R. B. Dash & D. Dalai, A Course on Mathematical Analysis, Kalyani Publishers.
2. K. A. Ross, Elementary Analysis: The Theory of Calculus, Springer, 2004.
3. R. Bartle and D.R. Sherbet, Introduction to Real Analysis, John Wiley and Sons, 2003
4. A. Mattuck, Introduction to Analysis, Prentice Hall, 1999.
5. S.R. Ghorpade and B.V. Limaye, A Course in Calculus and Real Analysis, Springer, 2006

C – 3.2: Group Theory (Algebra – II)

Total Marks: 100

Theory: 80 Marks + Mid-Sem: 20 Marks

UNIT – I

Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups. Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.

UNIT – II

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

UNIT – III

Properties of cosets, Lagranges theorem and consequences including Fermats Little theorem.

UNIT – IV

External direct product of a finite number of groups, normal subgroups, factor groups, Cauchys theorem for finite abelian groups.

UNIT – V

Group homomorphisms, properties of homomorphisms, Cayleys theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.

Book Recommended:

1. Joseph A. Gallian, Contemporary Abstract Algebra (8th Edn.), Narosa Publishing House, New Delhi. (Ch – 1,2,3,4,5,6,7,8,9,10,11)

Books for References:

- John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
- M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
- Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
- I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

C – 3.3:

Partial Differential Equations and Systems of Ordinary Differential Equations

Total Marks: 100

Part – I (Marks: 75)

Theory: 60 Marks + Mid-Sem: 15 Marks

UNIT – I

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients (Two Equations in two unknown functions). Simultaneous linear first order equations in three variables, methods of solution, Pfaffian differential equations, methods of solutions of Pfaffian differential equations in three variables.

UNIT – II

Formation of first order partial differential equations, Linear and non-linear partial differential equations of first order, special types of first-order equations, Solutions of partial differential equations of first order satisfying given conditions.

UNIT – III

Linear partial differential equations with constant coefficients, Equations reducible to linear partial differential equations with constant coefficients, Partial differential equations with variable coefficients.

UNIT – IV

Some standard forms of Variable Co-efficient, separation of variable (Product Method), Non-linear equation of the second order.

UNIT – V

Laplace equation, Solution of Laplace equation by separation of variables, One dimensional wave equation, Solution of the wave equation (method of separation of variables), Diffusion equation, Solution of one-dimensional diffusion equation, method of separation of variables.

Part – II

(Practical: Marks: 25)

List of Practicals (Using any Software)

Practical/Lab work to be performed on a Computer.

1. To find the general solution of the non-homogeneous system of the form:

$$\frac{dx}{dt} = a_1x + b_1y + f_1(t), \frac{dy}{dt} = a_2x + b_2y + f_2(t)$$

With given conditions.

2. Plotting the integral surfaces of a given first order PDE with initial data.
3. Solution of wave equation $\frac{\partial^2 u}{\partial t^2} - c^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions:

- (a) $u(x, 0) = \varphi(x)$, $u_t(x, 0) = \psi(x)$, $x \in R$, $t > 0$. (b) $u(x, 0) = \varphi(x)$, $u_t(x, 0) = \psi(x)$, $u_x(0, t) = 0$, $x \in (0, \infty)$, $t > 0$. (c) $u(x, 0) = \varphi(x)$, $u_t(x, 0) = \psi(x)$, $u(0, t) = 0$, $x \in (0, \infty)$, $t > 0$. (d) $u(x, 0) = \varphi(x)$, $u_t(x, 0) = \psi(x)$, $u(0, t) = 0$, $u(l, t) = 0$, $0 < x < l$, $t > 0$.

4. Solution of wave equation $\frac{\partial u}{\partial t} - k^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions:
- $u(x, 0) = \varphi(x)$, $u(0, t) = a$, $u(l, t) = b$, $0 < x < l$, $t > 0$.
 - $u(x, 0) = \varphi(x)$, $x \in R$, $0 < t < T$.
 - $u(x, 0) = \varphi(x)$, $u(0, t) = a$, $x \in (0, \infty)$, $t \geq 0$.

Book Recommended:

- J. Sinha Roy and S. Padhy, A Course on Ordinary and Partial Differential Equations, Kalyani Publishers, New Delhi, Ludhiana, 2012.
Chapters: 11, 12, 13(13.1-13.7), 15(15.1, 15.5), 16(16.1, 16.1.1), 17(17.1, 17.2, 17.3).

Books for References:

- Tyn Myint-U and Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint, 2006.
- S. L. Ross, Differential equations, 3rd Ed., John Wiley and Sons, India, 2004.

GENERIC ELECTIVES/ INTERDISCIPLINARY

(Credit: 06 each, Marks – 100)

SEMESTER – III

GE – III

CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS

UNIT – I

Curvature, Asymptotes, Tracing of Curves (Cartenary, Cycloid, Folium of Descartes, Astroid, Limacon, Cissoid & loops), Rectification, Quadrature, Volume and Surface area of solid of revolution.

UNIT – II

Sphere, Cone and Cylinder, Conicoid.

UNIT – III

Explicit and Implicit functions, Limit and Continuity of functions of several variables, Partial derivatives, Partial derivatives of higher orders, Homogeneous functions, Change of variables, Mean value theorem, Taylor's theorem and Maclaurin's theorem for functions of two variables. Maxima and Minima of functions of two and three variables, Implicit functions, Lagrange's multipliers, multiple integrals.

UNIT – IV

Ordinary Differential Equations of 1st order and 1st degree (Variables separable, homogeneous, exact and linear), Equations of 1st order but higher degree.

UNIT – V

Second order linear equations with constant coefficients, homogeneous forms; Second order equations with variable coefficients, Variation of parameters, Laplace transforms and its applications to solutions of differential equations.

Books Recommended:

5. R. K. Panda and P. K. Satapathy, Topics in Calculus, S. G. Publications. Chapter – I, II, III, IV.
6. B. P. Acharya and D.C. Sahu – Analytical Geometry of Quadratic Surfaces, Kalyani Publishers, New Delhi, Ludhiana.
7. Santosh K. Sengar-Advanced Calculus, Chapters: 2, 4, 5, 6, 7, 11, 12,13.
8. J. Sinharoy and S. Padhy-A Course of Ordinary and Partial Differential Equations, Kalyani Pub- lishers. Chapters: 2(2.1 to 2.7), 3, 4(4.1 to 4.7), 5, 9(9.1, 9.2, 9.3, 9.4, 9.5, 9.10, 9.11, 9.13).

Books for References:

2. Santinarayan – Text Book of Calculus, Part II & III.

SEMESTER – IV
C – 4.1:
NUMERICAL METHODS

(Total Marks: 100)

Part – I (Marks: 75)

Theory: 60 Marks + Mid-Sem: 15 Marks

UNIT – I

Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation. Transcendental and Polynomial equations: Bisection method, Regular Falsi method/ Newton's Raphsan method, Secant method, Rate of convergence of these methods, fixed point of a function, fixed point iteration method.

UNIT – II

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

UNIT – III

Interpolation: Lagrange and Newtons methods, Error bounds, Finite difference operators. Gregory forward and backward difference interpolation.

UNIT – IV

Numerical Integration: Trapezoidal rule, Simpsons $1/3^{\text{rd}}$ rule, Simpsons $3/8^{\text{th}}$ rule, Midpoint rule, Composite Trapezoidal rule, Composite Simpsons, Gauss Quadrature 2 point & 3 point rule.

UNIT – V

Ordinary Differential Equations: Picards Methods, Eulers method, Runge-Kutta methods of orders two and four, Numerical Differentiation: Simple numerical methods.

Part – II
(Practical: Marks: 25)

List of Practicals (Using any Software)

Practical/Lab work to be performed on a Computer.

1. Calculate the sum $1/1 + 1/2 + 1/3 + 1/4 + \dots + 1/N$.
2. To find the absolute value of an integer.
3. Enter 100 integers into an array and sort them in an ascending order.
4. Bisection Method.
5. Newton Raphson Method.
6. Secant Method.
7. Regulai Falsi Method.
8. LU decomposition Method.
9. Gauss-Jacobi Method.
10. SOR Method or Gauss-Siedel Method.
11. Lagrange Interpolation or Newton Interpolation.
12. Simpsons rule.

Note: For any of the CAS (Computer aided software) Data types-simple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input/output, relational operators, logical operators and logical expressions, control state- ments and loop statements, Arrays should be introduced to the students.

Book Recommended:

1. B.P. Acharya and R.N. Das, A Course on Numerical Analysis, Kalyani Publishers, New Delhi, Ludhiana. Chapters: 1, 2(2.1 to 2.4, 2.6, 2.8, 2.9), 3(3.1 to 3.4, 3.6 to 3.8), 5(5.1, 5.2), 6(6.1, 6.2, 6.3, 6.4, 6.5, 6.10, 6.11), 7(7.1, 7.2, 7.3, &7.7), 8(8.1, 8.2, 8.4)
2. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.

Books for References:

- M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Ed., New age International Publisher, India, 2007.
- C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.
- Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.
- John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, 4th Ed., PHI Learning Private Limited, 2012.

C – 4.2:
Riemann Integration and Series of Functions (Analysis – III)

Total Marks: 100

Theory: 80 Marks + Mid-Sem: 20 Marks

UNIT – I

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

UNIT – II

Improper integrals; Convergence of Beta and Gamma functions.

UNIT – III

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

UNIT – IV

Limit superior and Limit inferior. Power series, radius of convergence, Cauchy Hadamard Theorem,

UNIT – V

Differentiation and integration of power series; Abels Theorem; Weierstrass Approximation Theorem.

Book Recommended:

1. G. Das and S. Pattanayak-Fundamentals of Mathematics Analysis, TMH Publishing Co., Chapters: 4.8, 4.14, 4.15, (8.1-8.6), 9.

Books for References:

- K.A. Ross, Elementary Analysis, The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
- R.G. Bartle D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
- Charles G. Denlinger, Elements of Real Analysis, Jones & Bartlett (Student Edition), 2011.
- S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Ltd., New Delhi.
- Shanti Narayan and M.D. Raisinghania-Elements of Real Analysis, S. Chand & Co. Pvt. Ltd.

C – 4.3:
Ring Theory and Linear Algebra – I (Analysis – III)

Total Marks: 100

Theory: 80 Marks + Mid-Sem: 20 Marks

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 – II

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

UNIT – III

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

UNIT – IV

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

UNIT – V

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

Book Recommended:

1. Joseph A. Gallian, Contemporary Abstract Algebra(4th Edn.), Narosa Publishing House, New Delhi. Chapters:12, 13, 14, 15.
2. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice- Hall of India Pvt. Ltd., New Delhi, 2004. Chapters: 1 (1.2-1.6), 2(2.1-2.5).

Books for References:

- John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
- M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
- S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
- Gilbert Strang, Linear Algebra and its Applications, Cengage Learning India Pvt. Ltd.
- S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.
- Kenneth Hoffman, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
- I. N. Herstein-Topics in Algebra, Wiley Eastern Pvt. Ltd.
- Introduction to Linear Algebra – V. Krishnamurty & others.

SEMESTER – IV
GE – IV

LINEAR ALGEBRA AND ADVANCED ALGEBRA

UNIT – I

Vector space, Subspace, Span of a set, Linear dependence and Independence, Dimensions and Basis, Linear transformations, Range, Kernel, Rank, Nullity, Inverse of a linear map, Rank-Nullity theorem.

UNIT – II

Matrices and linear maps, Rank and Nullity of a matrix, Transpose of a matrix, Types of matrices, Elementary row operations, System of linear equations, Matrix inversion using row operations, Determinant and Rank of matrices, Eigen values, Eigen vectors, Quadratic forms.

UNIT – III

Group Theory: Definition and examples, Subgroups, Normal subgroups, Cyclic groups, Cosets, Quotient groups, Permutation groups, Homomorphism.

UNIT – IV

Ring Theory: Definition and examples, Some special classes of Rings, Ideals, Quotient rings, Ring homomorphism, Isomorphism theorems.

UNIT – V

Zero divisors, Integral domain, Finite fields, Finite field $\mathbb{Z}/p\mathbb{Z}$, Field of quotients of an Integral domain, Polynomial ring, Division algorithm, Remainder theorem, Factorization of polynomials, irreducible and reducible polynomials, Primitive polynomials, Irreducibility tests, Eisenstein Criterion.

Books Recommended:

3. V. Krishnamurty, V. P. Mainra, J. L. Arora-An introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd., New Delhi, Chapters: 3, 4(4.1 to 4.7), 5(except 5.3), 6(6.1, 6.2, 6.5, 6.6, 6.8), 7(7.4 only).
4. I. H. Seth, Abstract Algebra, Prentice Hall of India. (Ch.- 7,8,9,10,12,13,14,15,16,17,19,21)

Books for References:

2. I. N. Herstein, Topics in Algebra.

+3 3rd YEAR
SEMESTER – V

C – 5.1: Multivariate Calculus (Calculus-II)

Total Marks:100

Theory: 80 Marks + Mid-Sem: 20 Marks

UNIT – I

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.

UNIT – II

Directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes, Definition of vector field, divergence and curl

UNIT – III

Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems.

UNIT - IV

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

UNIT – V

Line integrals, Applications of line integrals: Mass and Work, Fundamental theorem for line integrals, conservative vector fields, independence of path, Greens theorem, surface integrals, integrals over parametrically defined surfaces, Stokes theorem, The Divergence theorem.

Books Recommended:

1. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007. Chapters: 11(11.1(Pages: 541-543), 11.2-11.6, 11.7(Pages:598- 605), 11.8(Pages:610-614)), 12 (12.1, -12.3, 12.4(Pages:652-660), 12.5, 12.6), 13 (13.2, 13.3, 13.4(Pages:712-716), 13.5(Pages:723-726; 729-730), 13.6 (Pages:733-737), 13.7(Pages:742-745)).

Books for Reference:

- G.B. Thomas and R. L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
- S. C. Mallik and S. Arora, Mathematical Analysis.
- Vector Calculus, N. Saran & R. Prasad.
- E. Marsden, A. J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer (SIE), Indian reprint, 2005.
- Santosh K. Sengar-Advanced Calculus, Cengage Learning India Pvt. Ltd.

C – 5.2: Probability and Statistics

Total Marks: 100

Theory: 80 Marks + Mid-Sem: 20 Marks

UNIT – I

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 – II

Discrete distributions: uniform, binomial, Poisson, geometric, negative binomial.

UNIT – III

Continuous distributions: uniform, normal, exponential, Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions.

UNIT – IV

Expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables.

UNIT – V

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, Markov Chains, Chapman-Kolmogorov equations, classification of states.

Books Recommended:

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007. Chapters: 1(1.1, 1.3, 1.4, 1.5-1.9), 2(2.1, 2.3-2.5).
2. Irwin Miller and Marylees Miller, John E. Freund, Mathematical Statistics with Applications, 7th Ed., Pearson Education, Asia, 2006. Chapters: 4, 5(5.1-5.5, 5.7), 6(6.2,6.3, 6.5-6.7), 14(14.1, 14.2)

Books for References:

- Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, Introduction to the Theory of Statistics, 3rd Ed., Tata McGraw- Hill, Reprint 2007.
- S. C. Gupta and V.K. Kapoor-Fundamentals of Mathematical Statistics, S. Chand and Company Pvt. Ltd., New Delhi.
- S. Ross-A First Course in Probability, Pearson Education.
- Introduction to probability models, Sheldon Ross, Academic Press, Indian Reprint 2007

SEMESTER – VI

C – 6.1: Metric Spaces and Complex Analysis (Analysis-IV)

Total Marks: 100

Theory: 80 Marks + Mid-Sem: 20 Marks

UNIT – I

Metric spaces: definition and examples. Sequences in metric spaces, Cauchy sequences. Complete Metric Spaces. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, Cantors theorem.

UNIT – II

Subspaces, dense sets, separable spaces, Continuous mappings, sequential criterion and other characterizations of continuity, Uniform continuity, Homeo- morphism, Contraction mappings, Banach Fixed point Theorem, Connectedness, connected subsets of \mathbb{R} .

UNIT - III

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 – IV

Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigono- metric 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 – V

Liouvilles 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. P.K. Jain and K. Ahmad, Metric Spaces, Narosa Publishing House, New Delhi. Chapters: 2(1-9), 3(1-4), 4(1-4), 6(1-2), 7(1 only).
2. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed., McGraw Hill International Edition, 2009. Chapters: 1(11 only), 2(12,13), 2(15-22, 24, 25), 3(29, 30, 34) 4(37-41, 43-46, 50-53), 5(55-60, 62,63,66).

Books for References:

- Satish Shirali and Harikishan L. Vasudeva, Metric Spaces, Springer Verlag, London, 2006.
- S. Kumaresan, Topology of Metric Spaces, 2nd Ed., Narosa Publishing House, 2011.
- S. Ponnusamy-Foundations of Complex Analysis, Alpha Science International Ltd.
- J.B. Conway-Functions of one complex variable, Springer.
- N. Das- Complex Function Theory, Allied Publishers Pvt. Ltd., Mumbai.

C – 6.2: Linear Programming

Total Marks: 100

Theory: 80 Marks + Mid-Sem: 20 Marks

UNIT – I

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

UNIT – II

Introduction to artificial variables, twophase method, BigM method and their comparison.

UNIT - III

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

UNIT – IV

Transportation problem and its mathematical formulation, north-west 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 – V

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.

Recommended Books:

1. Kanti Swarup, P. K. Gupta and Man Mohan-Operations Research, S. Chand and Co. Pvt. Ltd. (Ch 3, 4, 5) (Ex. 5.9), 10(Ex. 14, 15, 16), 11(Ex. 11.4-11.6), 17.

Books for Reference:

- Chapter: 3, 4, 5(Ex 5.9), 10, 11(11.4, 11.5, 11.6), (Ex 14,15,16), 17
- Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004. Chapters: 3(3.2-3.3, 3.5-3.8), 4(4.1-4.4), 6(6.1-6.3).
- F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Ed., Tata McGraw Hill, Singapore, 2009. Chapter:14
- Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice Hall India, 2006. Chapter: 5(5.1, 5.3, 5.4).
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- G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.
- N.V.R. Naidu, G. Rajendra and T. Krishna Rao-Operations Research, I.K. International Publishing House Pvt. Ltd., New Delhi, Bangalore.
- R. Veerachamy and V. Ravi Kumar-Operations Research- I.K. International Publishing House Pvt. Ltd., New Delhi, Bangalore.
- P.K. Gupta and D.S. Hira-Operations Research, S. Chand and Company Pvt. Ltd., New Delhi.

DISCIPLINE SPECIFIC ELECTIVES (DSE)

SEMESTER – V

DSE – I

Programming in C++ (Compulsory)

Part – I (Marks: 75)

(Theory: 60 Marks + Mid-Sem: 15 Marks)

UNIT – I

Introduction to structured programming: data types- simple data types, floating data types, character data types, string data types, arithmetic operators and operators precedence, variables and constant declarations, expressions, input using the extraction operator `&&` and `cin`, output using the insertion operator `&&` and `cout`, preprocessor directives, increment(++), and decrement(–) operations, creating a C++ program, input/ output.

UNIT – II

Relational operators, logical operators and logical expressions, if and if-else statement, switch and break statements.

UNIT – III

For, while and do-while loops and continue statement, nested control statement,

UNIT – IV

Value returning functions, value versus reference parameters, local and global variables,

UNIT – V

One dimensional array, two dimensional array, pointer data and pointer variables.

Book Recommended:

1. D. S. Malik: C++ Programming Language, Edition-2009, Course Technology, Cengage Learning, India Edition. Chapters: 2(Pages:37-95), 3(Pages:96-129), 4(Pages:134-178), 5(Pages:181-236), 6, 7(Pages:287-304), 9(pages:357-390), 14(Pages:594-600).

Books for References:

- E. Balaguruswami: Object oriented programming with C++, fifth edition, Tata McGraw Hill Education Pvt. Ltd.
- R. Johnsonbaugh and M. Kalin-Applications Programming in ANSI C, Pearson Education.
- S. B. Lippman and J. Lajoie, C++ Primer, 3rd Ed., Addison Wesley, 2000.
- Bjarne Stroustrup, The C++ Programming Language, 3rd Ed., Addison Welsley.

Part – II
(Practical, Marks: 25)

List of Practicals (Using any software)
Practical/Lab work to be performed on a Computer.

1. Calculate the Sum of the series $\frac{1}{1} + \frac{1}{2} + \frac{1}{3} \dots + \frac{1}{N}$ for any positive integer N .
2. Write a user defined function to find the absolute value of an integer and use it to evaluate the function $(-1)^n/n!$, for $n = -2, -1, 0, 1, 2$.
3. Calculate the factorial of any natural number.
4. Read floating numbers and compute two averages: the average of negative numbers and the average of positive numbers.
5. Write a program that prompts the user to input a positive integer. It should then output a message indicating whether the number is a prime number.
6. Write a program that prompts the user to input the value of a , b and c involved in the equation $ax^2 + bx + c = 0$ and outputs the type of the roots of the equation. Also the program should outputs all the roots of the equation.
7. Write a program that generates random integer between 0 and 99. Given that first two Fibonacci numbers are 0 and 1, generate all Fibonacci numbers less than or equal to generated number.
8. Write a program that does the following:
 - a. Prompts the user to input five decimal numbers.
 - b. Prints the five decimal numbers.
 - c. Converts each decimal number to the nearest integer.
 - d. Adds these five integers.
 - e. Prints the sum and average of them.
9. Write a program that uses whileloops to perform the following steps:
 - a. Prompt the user to input two integers: first Num and second Num (first Num should be less than second Num).
 - b. Output all odd and even numbers between first Num and second Num.
 - c. Output the sum of all even numbers between first Num and second Num.
 - d. Output the sum of the square of the odd numbers first Num and second Num.
 - e. Output all uppercase letters corresponding to the numbers between first Num and second Num, if any.
10. Write a program that prompts the user to input five decimal numbers. The program should then add the five decimal numbers, convert the sum to the nearest integer, and print the result.
11. Write a program that prompts the user to enter the lengths of three sides of a triangle and then outputs a message indicating whether the triangle is a right triangle or a scalene triangle.
12. Write a value returning function smaller to determine the smallest number from a set of numbers. Use this function to determine the smallest number from a set of 10 numbers.
13. Write a function that takes as a parameter an integer (as a long value) and returns the number of odd, even, and zero digits. Also write a program to test your function.
14. Enter 100 integers into an array and sort them in an ascending/ descending order and print the largest/ smallest integers.
15. Enter 10 integers into an array and then search for a particular integer in the array.
16. Multiplication/ Addition of two matrices using two dimensional arrays.
17. Using arrays, read the vectors of the following type: $A = (12345678)$, $B = (02340156)$ and compute the product and addition of these vectors.
18. Read from a text file and write to a text file.

19. Write a function, reverse Digit, which takes an integer as a parameter and returns the number with its digits reversed. For example, the value of function reverse Digit12345 is 54321 and the value of reverse Digit –532 is –235.

SEMESTER – V **DSE - II**

Total Marks: 100

Theory: 80 Marks + Mid-Sem: 20 Marks

1-Discrete Mathematics

UNIT – I

Logic, propositional equivalence, predicates and quantifiers, nested quantifiers, methods of proof, relations and their properties, n-ary relations and their applications, Boolean functions and their representation.

UNIT – II

The basic counting, the Pigeon-hole principle, Generalized Permutations and Combinations.

UNIT – III

Recurrence relations, Counting using recurrence relations, Solving linear homogeneous recurrence relations with constant coefficients, Generating functions, Solving recurrence relations using generating functions.

UNIT – IV

Partially ordered sets, Hasse diagram of partially ordered sets, maps between ordered sets, duality principle, Lattices as ordered sets, Lattices as algebraic structures, sublattices, Boolean algebra and its properties.

UNIT – V

Graphs: Basic concepts and graph terminology, representing graphs and graph isomorphism. Distance in a graph, Cut-vertices and Cut-edges, Connectivity, Euler and Hamiltonian path.

Book Recommended:

1. Kenneth H. Rosen, Discrete Mathematics and Applications, Tata McGraw Hill Publications, Chapters: 1(1.1 to 1.5), 4(4.1, 4.2, 4.5), 6(6.1, 6.2, 6.5, 6.6), 7(7.1, 7.2), 8,10(10.1,10.2).

Books for References:

- B A. Davey and H. A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge, 1990.
- Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory (2nd Edition), Pearson Education (Singapore) Pte. Ltd., Indian Reprint 2003.
- Rudolf Lidl and Gnter Pilz, Applied Abstract Algebra (2nd Edition), Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
- D.S. Malik-Discrete Mathematics: Theory & Applications, Cengage Learning India Pvt. Ltd.
- Kevin Ferland-Discrete Mathematical Structures, Cengage Learning India Pvt. Ltd.

SEMESTER – VI **DSE – III**

Total Marks: 100

Theory: 80 Marks + Mid-Sem: 20 Marks

1-Differential Geometry

UNIT – I

Theory of Space Curves: Space curves, Planer curves, Curvature, torsion and Serret-Frenet formulae, Helix Involute, Osculating circles, Osculating circles and spheres. Existence of space curves, Evolutes and involutes of curves.

UNIT – II

Evolute, Surfaces, Tangent plane, normal envelop, edge of regression, Developable surfaces. Osculating circles, Osculating circles and spheres, Existence of space curves.

UNIT – III

Curvilinear coordinates, First order magnitudes, Directions on a surface, The normal, Second order magnitudes, derivatives of normal.

UNIT – IV

Curvature of Normal section, Principal directions, First & Second curvatures, Euler's Theorem.

UNIT – V

Conjugate directions, Asymptotic lines, Curvature & Torsion, Geodesic: Geodesic equation, Curvature & Torsion.

Book Recommended:

1. C.E. Weatherburn, Differential Geometry of Three Dimensions, Cambridge University Press 2003. Chapters:1(1-4, 7,8,10,11), 2(13, 14, 15, 16, 17,18), 3, 4(29-31, 35, 37, 38), 6(46,47,49).

Books for References

- T.J. Willmore, An Introduction to Differential Geometry, Dover Publications, 2012.
- S. Lang, Fundamentals of Differential Geometry, Springer, 1999.
- B. O'Neill, Elementary Differential Geometry, 2nd Ed., Academic Press, 2006.
- A.N. Pressley-Elementary Differential Geometry, Springer.
- B.P. Acharya and R.N. Das-Fundamentals of Differential Geometry, Kalyani Publishers, Ludhiana, New Delhi.

SEMESTER – VI
DSE – IV

A Project work is to be undertaken by the student in consultation with the teachers of the department. The student has to prepare the project under the supervision of a teacher of the department. Further, he/she has to submit one Seminar Paper in the department.

Project Work/ Seminar	- 100 Marks
A) Dissertation/ Viva-voce	- 75 Marks
B) Seminar	- 25 Marks

The project work is to be evaluated by both the Internal & External Examiners and an External Examiner is to be invited to conduct the Project Evaluation and Viva-Voce.