

Proposed Syllabus

for

B.A. & B.Sc. First to Fourth Semester Mathematics (Hons.)

DEPARTMENT OF MATHEMATICS

JAGANNATH BAROOAH COLLEGE

Under the

Choice Based Credit System

2016-2017

Structure

Semester	Core Course	Ability Enhancement Compulsory Course (AECC)(2)	Skill Enhancement Course (SEC)(2)	Elective Discipline DSE(4)	Generic Elective (GE) (4)
I	C1 Calculus (including practicals)	(English /MIL Communication) / Environmental Science			GE-1 (Trigonometry & Analysis I)
	C2 Algebra				
II	C3 Real Analysis	Environmental Science / (English /MIL Communication)			GE-2 (Analysis II)
	C4 Differential Equations (including practicals)				
III	C5 Theory of Real Functions		SEC 1 (Latex & HTML/Computer Graphics)		GE-3 (Computational Methods)
	C6 Group Theory I				
	C7 PDE and Systems of ODE (including practicals)				
IV	C8 Numerical Methods (including practicals)		SEC 2 (Graph Theoretic Modeling/Operating System :Linux)		GE-4 (Coordinate Geometry & Abstract Algebra)
	C9 Riemann Integration and Series of Functions				
	C10 Ring Theory and Linear Algebra I				
V	C11 Multivariate Calculus			DSE-1	
	C12 Group Theory II			DSE-2	
VI	C13 Metric Spaces and Complex Analysis			DSE-3	
	C14 Ring Theory and Linear Algebra II			DSE-4	

Discipline Specific Electives (DSE)

Choices for DSE 1 (choose one)

1. Number Theory
2. C++ Programming
3. Mathematical Finance

Choices for DSE 2 (choose one)

1. Industrial Mathematics
2. Boolean Algebra and Automata Theory
3. Cryptography and Network Security

Choices for DSE 3 (choose one)

1. Theory of Equations
2. Bio-Mathematics
3. Linear Programming

Choices for DSE 4 (choose one)

1. Mathematical Modeling
2. Mechanics
3. Differential Geometry

Skill Enhancement Course (SEC)

Choices for SEC 1 (choose one)

1. Latex & HTML
2. Computer Graphics

Choices for SEC 2 (choose one)

1. Graph Theoretic Modeling
2. Operating System: Linux

Generic Electives (GE)

GE 1

Trigonometry & Analysis I

GE 2

Analysis II

GE 3

Computational Methods

GE 4

Coordinate Geometry & Abstract Algebra

Details of courses under B.A./ B.Sc. (Hons.) Mathematics

Course	*Credits	
	Theory + Practical	Theory + Tutorial
I. Core Course (14 Papers)	$14 \times 4 = 56$	$14 \times 5 = 70$
Core Course Practical / Tutorial* (14 Papers)	$14 \times 2 = 28$	$14 \times 1 = 14$
II. Elective Course (8 Papers)		
A.1. Discipline Specific Elective (4 Papers)	$4 \times 4 = 16$	$4 \times 5 = 20$
A.2. Discipline Specific Elective Practical/ Tutorial* (4 Papers)	$4 \times 2 = 8$	$4 \times 1 = 4$
B.1. Generic Elective/ Interdisciplinary (4 Papers)	$4 \times 4 = 16$	$4 \times 5 = 20$
B.2. Generic Elective Practical/ Tutorial* (4 Papers)	$4 \times 2 = 8$	$4 \times 1 = 4$
<input type="checkbox"/> Optional Dissertation or project work in place of one Discipline Specific Elective Paper (6 credits) in 6th Semester		
III. Ability Enhancement Courses		
1.Ability Enhancement Compulsory Courses (AECC) (2 Papers of 2 credit each)	$2 \times 2 = 4$	$2 \times 2 = 4$
Environmental Science English/MIL Communication		
2. Skill Enhancement Courses (SEC) (Minimum 2) (2 Papers of 2 credit each)	$2 \times 2 = 4$	$2 \times 2 = 4$
Total credit	140	140

[Institute should evolve a system/ policy about ECA/ General Interest/ Hobby/ Sports/ NCC/ NSS/ related courses on its own.]

* wherever there is a practical there will be no tutorial and vice-versa

C1: Calculus

Total marks: 100; Total credit : 6;

Theory: 65, Practical: 35;

(Credits: Theory-04, Practicals-02)

5 Lectures per week, 2 Practical per week (2 hour practical class)

Objective: Students will be able to identify the analytical aspects of Mathematical concepts and will be able to handle practical problems. By Computer Laboratory, they will be exposed to a hand on experience on various Mathematical Software.

Theory classes : 60. E.S.E.-50, I.S.E.-15

Unit-I: Hyperbolic functions, higher order derivatives, Leibniz rule and its applications to problems of

type $e^{ax+b} \sin x, e^{ax+b} \cos x, (ax + b)^n \cos x, (ax + b)^n \sin x$, concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L'Hospital's rule, applications in business, economics and life sciences.

(18 Classes) MARKS:15

Unit-II: Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin nx \, dx, \int \cos nx \, dx, \int \tan nx \, dx, \int \sec nx \, dx, \int (\log x)^n \, dx, \int \sin^n x \cos^m x \, dx$, volumes by slicing, disks and washers methods, volumes by cylindrical shells, 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.

(25 Classes) MARKS:20

Unit-III: 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.

(17 Classes) MARKS:15

Practical Classes : 30 (2 hour per practical class) E.S.E.-30, I.S.E.-5

List of Practicals (using software MATLAB/MATHEMATICA/MAPLE)

- (i) Plotting of graphs of function $e^{ax+b}, \log(ax + b), 1/(ax + b), \sin(ax + b), \cos(ax + b), |ax + b|$ and to illustrate the effect of a and b on the graph.
- (ii) Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.
- (iii) Sketching parametric curves (E.g. Trochoid, cycloid, epicycloids, hypocycloid).
- (iv) Obtaining surface of revolution of curves.

- (v) Tracing of conics in cartesian coordinates/ polar coordinates.
- (vi) Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, hyperbolic paraboloid using cartesian coordinates.
- (vii) Matrix operation (addition, multiplication, inverse, transpose).

Text Book:

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005
2. B. C. Das & B. N. Mukherjee, *Differential Calculus*, U. N. Dhur and Sons. Pvt Ltd
3. S. Narayan & P. K. Mittal, *Integral Calculus*, S. Chand Publishing
4. S. Narayan & P. K. Narayan, *A Text Book on Vector Calculus*, S. Chand Publishing\

Reference Books:

1. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
3. R. Courant and F. John, *Introduction to Calculus and Analysis* (Volumes I & II), Springer-Verlag, New York, Inc., 1989.

C2: Algebra

Total Marks: 100;

Theory: 80; Internal Assessment: 20;

(Credits: Theory-05, Tutorials-01)

5 Lectures, 1 Tutorial (per week)

Objective : The students can have a deeper insight of the developments of the generalized notions of Trigonometry, Also, will be able to use matrix methods for solving linear equations.

Theory Classes : 75, Tutorial Classes : 15. E.S.E.-80, I.S.E.-20

Unit-I: Polar representation of complex numbers, n th roots of unity, De Moivre's theorem for rational indices and its applications. **(10 Lectures) MARKS: 10**

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.

(25 Lectures) MARKS:20

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. **(20 Lectures) MARKS: 25**

Unit-IV: Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices. Subspaces of R^n , dimension of subspaces of R^n and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix.

(20 Lectures) MARKS:25

Text Book:

1. Hall & Night, Higher Algebra, Arihant Publishers.
2. Kenneth Hoffman, Ray Alden Kunze, *Linear Algebra*, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
3. S. L. Loney, Plane Trigonometry, University Press Publishers.

Reference Books:

1. Titu Andreescu and Dorin Andrica, *Complex Numbers from A to Z*, Birkhauser, 2006.
2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory*, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
3. David C. Lay, *Linear Algebra and its Applications*, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.

C3: Real Analysis

Total Marks: 100

Theory: 80 , Internal Assessment: 20

(Credits: Theory-05, Tutorials-01)

5 Lectures, 1 Tutorial (per week)

Objective: To infuse the classical ideas of algebraic and analytic structures.

Theory Classes : 75, Tutorial Classes : 15. E.S.E.-80, I.S.E.-20

Unit-I: Review of Algebraic and Order Properties of \mathbb{R} , δ -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, 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.

(31 Lectures) MARKS: 30

Unit-II: 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.

(22 Lectures) MARKS: 25

Unit-III: 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, Alternating series, Leibniz test, Absolute and Conditional convergence.

(22 Lectures) MARKS: 25

Text Book:

1. R.G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. A. Kumar and S. Kumarasen, *A Basic Course in Real Analysis*, CRC Press
3. G. B. Thomas and R. L. Finney, *Calculus*, Pearson.

Reference Books:

1. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, *An Introduction to Analysis*, 2nd Ed., Jones & Bartlett, 2010.
2. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, *Elementary Real Analysis*, Prentice Hall, 2001.
3. S.K. Berberian, *A First Course in Real Analysis*, Springer Verlag, New York, 1994.

C4: Differential Equations

Total marks: 100; Total credit: 6;

Theory: 65, Practical: 35;

(Credits: Theory-04, Practicals-02)

5 Lectures per week, 2 Practical per week (2 hour practical class)

Objectives : Students will be able to understand the basic idea of mathematical model by using differential equations, and ideas on the basics of differential equations.

Theory classes : 60. E.S.E.-50, I.S.E.-15

Unit-I: Differential equations and mathematical models. 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, linear equation and Bernoulli equations, special integrating factors and transformations.

(15 Classes) MARKS: 10

Unit-II: Introduction to compartmental model, exponential decay model, lake pollution model (case study of Lake Burley Griffin), drug assimilation into the blood (case of a single cold pill, case of a course of cold pills), exponential growth of population, limited growth of population, limited growth with harvesting.

(15 Classes) MARKS: 10

Unit-III: General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters

(20 Classes) MARKS: 20

Unit-IV: Equilibrium points, Interpretation of the phase plane, predatory-prey model and its analysis, epidemic model of influenza and its analysis, battle model and its analysis.

(10 Classes) MARKS: 10

Practical classes : 30 (2 hour per practical class)

List of Practicals (using any software) E.S.E.-30, I.S.E.-5

1. Plotting of second order solution family of differential equation.
2. Plotting of third order solution family of differential equation.
3. Growth model (exponential case only).
4. Decay model (exponential case only).
5. Lake pollution model (with constant/seasonal flow and pollution concentration).
6. Case of single cold pill and a course of cold pills.
7. Limited growth of population (with and without harvesting).
8. Predatory-prey model (basic volterra model, with density dependence, effect of DDT, two prey one predator).
9. Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).

10. Battle model (basic battle model, jungle warfare, long range weapons).
11. Plotting of recursive sequences.
12. Study the convergence of sequences through plotting.
13. Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot.
14. Study the convergence/divergence of infinite series by plotting their sequences of partial sum.
15. Cauchy's root test by plotting n^{th} roots.
16. Ratio test by plotting the ratio of n^{th} and $(n + 1)^{\text{th}}$ term.

Text Book:

1. S.L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, India, 2004.
2. E. A. Coddington, *An Introduction to Ordinary Differential Equation*, Dover Publications.

Reference Books:

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

C5: Theory of Real Functions

Total Marks: 100;

Theory: 80; Internal Assessment: 20;

(Credits: Theory-05, Tutorials-01)

5 Lectures, 1 Tutorial (per week)

Objective:

Theory Classes : 75, Tutorial Classes : 15. E.S.E.-80, I.S.E.-20

Unit-I: Limits of functions ($\varepsilon - \delta$ 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. 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. **(22 Classes) MARKS: 25**

Unit-II: Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremum theorem. Rolle's theorem, Mean value theorem, intermediate value property of derivatives, Darboux's theorem. Applications of mean value theorem to inequalities and approximation of polynomials, Taylor's theorem to inequalities. **(30 Classes) MARKS: 30**

Unit-III: Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, Convex function, 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 $(1+x)^n$.

(23 Classes) MARKS: 25

Text Book:

1. R. Bartle and D.R. Sherbert, *Introduction to Real Analysis*, John Wiley and Sons, 2003.
2. S.R. Ghorpade and B.V. Limaye, *A Course in Calculus and Real Analysis*, Springer, 2006.
3. *Mathematical Analysis*, Apostole

Reference Books:

1. K.A. Ross, *Elementary Analysis: The Theory of Calculus*, Springer, 2004.
2. A. Mattuck, *Introduction to Analysis*, Prentice Hall, 1999.

C6: Group Theory I

Total Marks: 100;
Theory: 80; Internal Assessment: 20;
(Credits: Theory-05, Tutorials-01)
5 Lectures, 1 Tutorial (per week)

Objective:

Theory Classes : 75, Tutorial Classes : 15. E.S.E.-80, I.S.E.-20

Unit-I: Definition and examples of groups including, abelian groups, permutation groups and quaternion groups (illustration through matrices), Symmetries of a triangle, square, Dihedral groups, elementary properties of groups.

(15 Classes) MARKS: 15

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, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem.

(18 Classes) MARKS: 20

Unit-III: Product of two subgroups, External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

(15 Classes) MARKS: 15

Unit-IV: Subgroups and examples of subgroups, normal subgroups, cosets, centralizer, normalizer, center of a group.

(12 Classes) MARKS: 15

Unit-V: Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.

(15 Classes) MARKS: 15

Text Book:

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. *Abstract Algebra*, Khanna & Bhambri
4. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, New Delhi, 1999.

Reference Books:

1. Joseph J. Rotman, *An Introduction to the Theory of Groups*, 4th Ed., Springer Verlag, 1995.
2. I.N. Herstein, *Topics in Algebra*, Wiley Eastern Limited, India, 1975.

C7: PDE and Systems of ODE

Total marks: 100; Total credit: 6;

Theory: 65, Practical: 35;

(Credits: Theory-04, Practicals-02)

5 Lectures per week, 2 Practical per week (2 hour practical class)

Objectives : Students will be able to understand the basic idea of mathematical model by using partial differential equations, and ideas on the basics of partial differential equations.

Theory classes : 60. E.S.E.-50, I.S.E.-15

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, The method of successive approximations, the Euler method, the modified Euler method, The Runge-Kutta method. **(15 Classes) MARKS: 14**

Unit-II: Partial Differential Equations – Basic concepts and Definitions, Mathematical Problems. First-Order Equations: Classification, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations. Canonical Forms of First-order Linear Equations. Method of Separation of Variables for solving first order partial differential equations. **(18 Classes) MARKS: 14**

Unit-III: Derivation of Heat equation, Wave equation and Laplace equation solution using method of separation of variables. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order Linear Equations to canonical forms. **(15 Classes) MARKS: 12**

Unit-IV: The Cauchy problem, Cauchy problem of an infinite string. Initial Boundary Value Problems, Solving the Vibrating String Problem, Solving the Heat Conduction problem. **(12 Classes) MARKS: 10**

List of Practicals (using any software)**(30 Classes) MARKS: 35**

- (i) Solution of Cauchy problem for first order PDE.
(ii) Finding the characteristics for the first order PDE.
(iii) Plot the integral surfaces of a given first order PDE with initial data.
(iv) 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) $u(x, 0) = \phi(x), u_t(x, 0) = \psi(x), x \in R, t > 0$
(b) $u(x, 0) = \phi(x), u_t(x, 0) = \psi(x), u(0, t) = 0, x \in (0, \infty), t > 0$
(c) $u(x, 0) = \phi(x), u_t(x, 0) = \psi(x), u_x(0, t) = 0, x \in (0, \infty), t > 0$
(d) $u(x, 0) = \phi(x), u_t(x, 0) = \psi(x), u(0, t) = 0, u(l, t) = 0, 0 < x < l, t > 0$

- (v) Solution of wave equation $\frac{\partial u}{\partial t} - k^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions

- (a) $u(x, 0) = \phi(x), u(0, t) = a, u(l, t) = b, 0 < x < l, t > 0$
(b) $u(x, 0) = \phi(x), x \in R, 0 < t < T$
(c) $u(x, 0) = \phi(x), u(0, t) = a, x \in (0, \infty), t \geq 0$

Text Book:

1. S.L. Ross, *Differential equations*, 3rd Ed., John Wiley and Sons, India, 2004.
2. I. N. Sneddon, *Elements of Partial Differential Equations*, Dover Publications.

Reference Books:

1. Tyn Myint-U and Lokenath Debnath, *Linear Partial Differential Equations for Scientists and Engineers*, 4th edition, Springer, Indian reprint, 2006.
2. Martha L Abell, James P Braselton, *Differential equations with MATHEMATICA*, 3rd Ed., Elsevier Academic Press, 2004.

C8: Numerical Methods

Total marks: 100; Total credit: 6;

Theory: 65, Practical: 35;

(Credits: Theory-04, Practicals-02)

5 Lectures per week, 2 Practical per week (2 hour practical class)

Objectives :

Theory classes : 60.

E.S.E.-50, I.S.E.-15

Unit-I: Flow chart , Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation. Transcendental and Polynomial equations: Bisection method, Newton's method, Secant method. Rate of convergence of these methods. **(15 Classes) MARKS: 12**

Unit-II: System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis. **(12 Classes) MARKS: 10**

Unit-II: Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation. **(12 Classes) MARKS: 10**

Unit-III: Numerical Integration: Trapezoidal rule, Simpson's rule, Simpsons 3/8th rule, Boole's Rule. Midpoint rule, Composite Trapezoidal rule, Composite Simpson's rule. **(13 Classes) MARKS: 10**

Unit-IV: Ordinary Differential Equations: Euler's method. Runge-Kutta methods of orders two and four. **(8 Classes) MARKS: 8**

List of Practicals (using any software)

(30 Classes) MARKS: 35

- (i) Calculate the sum $1/1 + 1/2 + 1/3 + 1/4 + \dots + 1/N$.
- (ii) To find the absolute value of an integer.
- (iii) Enter 100 integers into an array and sort them in an ascending order.
- (iv) Bisection Method.
- (v) Newton Raphson Method.
- (vi) Secant Method.
- (vii) Regulai Falsi Method.
- (viii) LU decomposition Method.
- (ix) Gauss-Jacobi Method.
- (x) SOR Method or Gauss-Siedel Method.
- (xi) Lagrange Interpolation or Newton Interpolation.
- (xii) Simpson's rule.

Text Book:

1. 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.
2. *Getting Started with Matlab*, Rudra pratap, OXFORD , University Press. Reprint 2011.
3. K. Atkinson, **An Introduction to Numerical Analysis (2nd Edition)**, Wiley Publications
- 4.

Reference Books:

1. Brian Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.
2. C.F. Gerald and P.O. Wheatley, *Applied Numerical Analysis*, Pearson Education, India, 2008.
3. Uri M. Ascher and Chen Greif, *A First Course in Numerical Methods*, 7th Ed., PHI Learning Private Limited, 2013.
4. John H. Mathews and Kurtis D. Fink, *Numerical Methods using Matlab*, 4th Ed., PHI Learning Private Limited, 2012.

C9: Riemann Integration and Series of Functions

Total Marks: 100;

Theory: 80; Internal Assessment: 20;

(Credits: Theory-05, Tutorials-01)

5 Lectures, 1 Tutorial (per week)

Objective: To

Theory Classes : 75, Tutorial Classes : 15. E.S.E.-80, I.S.E.-20

Unit-I: Limit superior and Limit inferior, Riemann integration: Darboux's theorem, inequalities of upper and lower sums; Riemann conditions of integrability, Riemann limit of 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

(22Classes) MARKS:25

Unit-II: Improper integrals of all kinds & its convergence; Beta and Gamma functions and its properties & applications

(8 Classes) MARKS:20

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.

(20 Classes) MARKS:17

Unit-IV: Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and integration of power series; Abel's Theorem; Weierstrass Approximation Theorem.

(17 Classes) MARKS:18

Text Book:

1. *Real Analysis* , Walter Ruddin
2. R. Bartle and D.R. Sherbert, *Introduction to Real Analysis*, John Wiley and Sons, 2003.
3. S.R. Ghorpade and B.V. Limaye, *A Course in Calculus and Real Analysis*, Springer, 2006.

Reference Books:

1. K.A. Ross, *Elementary Analysis, The Theory of Calculus*, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
2. Charles G. Denlinger, *Elements of Real Analysis*, Jones & Bartlett (Student Edition), 2011.

C10: Ring Theory and Linear Algebra I

Total Marks: 100;

Theory: 80; Internal Assessment: 20;

(Credits: Theory-05, Tutorials-01)

5 Lectures, 1 Tutorial (per week)

Objective:

Theory Classes : 75, Tutorial Classes : 15. E.S.E.-80, I.S.E.-20

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. **(22 Classes) MARKS:25**

Unit-II: Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III, field of quotients. **(13 Classes) MARKS:15**

Unit-III: Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces. **(18 Classes) MARKS:20**

Unit-IV: 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, change of coordinate matrix. **(22 Classes) MARKS:20**

Text Book:

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
2. P.K. Saikia , “*Linear Algebra*”
3. K.P.Gupta , “*Linear Algebra*”
4. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, New Delhi, 1999.
5. S. Kumaresan, *Linear Algebra- A Geometric Approach*, Prentice Hall of India,1999.

Reference Books:

1. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
2. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra*, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
3. S. Lang, *Introduction to Linear Algebra*, 2nd Ed., Springer, 2005.
4. D.A.R. Wallace, *Groups, Rings and Fields*, Springer Verlag London Ltd., 1998.
5. Kenneth Hoffman, Ray Alden Kunze, *Linear Algebra*, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.

GE 1 Trigonometry & Analysis I

Total marks: 100

Theory: 80; Internal Assessment: 20;

(Credits: Theory-05, Tutorials-01)

5 Lectures , 4 Tutorials (per week)

Theory Classes : 75 , Tutorial Classes :15. E.S.E.-80, I.S.E.-20

Objective: Students will be able to use matrix methods for solving linear equations and also about the numerical methods of obtaining results where complexity of obtaining analytical solutions is sufficiently high.

Trigonometry

Unit-I: De Moivre's theorem and important deductions from De Moivre's theorem
(5 Classes) MARKS:8

Unit-II: Trigonometrical and exponential functions of complex arguments., Hyperbolic functions.
(5 Classes) MARKS: 8

Vector Calculus

Ordinary derivatives of vectors , Space curves, Continuity and differentiability, Differentiation formulae, Partial derivatives of vectors and related problems, Vector differential operator del , Gradient, Directional derivative, Divergence and Curl, Laplacian operator ∇^2 , Vector identities and related problems.
(14 Classes) MARKS: 16

Matrices

Unit-I: Rank of a matrix, Elementary operations on a matrix, determination of rank by reduction into echelon form & normal form, elementary matrices.
(5 Classes) MARKS: 5

Unit-II: Solution of homogeneous & non- homogeneous linear equations, Characteristic Polynomial, Characteristic equation, Eigen values and Eigen vectors, Cayley-Hamilton theorem.
(10Classes) MARKS: 10

Unit-III: Special types of matrices: idempotent, nilpotent, involution, and projection tridiagonal matrices, circulant matrices, Vandermonde matrices, Hadamard matrices. Positive Semi-definite matrices: positive semi-definite matrices, square root of a positive semi-definite matrix, a pair of positive semi-definite matrices, and their simultaneous diagonalization. Symmetric matrices and quadratic forms: diagonalization of symmetric matrices, quadratic forms.

(12 Classes) MARKS: 7

Numerical Analysis

Unit-I: Solution of algebraic and transcendental equation: Bisection method, Regula-falsi method, Iteration method, Newton-Raphson method and its geometrical interpretation. Solution of system of equations: Gauss elimination method, Gauss Seidal Method, Gauss Jordan method. **(12 Classes) MARKS: 13**

Unit-II: Diagonal and horizontal differential table, finite difference operators, Newton's forward, backward and general interpolation formulae, Lagrange's interpolation formula, Quadrature: Trapezoidal rule, Simpson's quadrature (1/3 and 3/8 rule). **(12 Classes) MARKS: 13**

Books Recommended

1. **Higher Trigonometry;** B.C. Das , B.N. Mukherjee, U.N. Dhur and Sons, Calcutta
2. **Text book of vector calculus;** Shanti Narayan, J. N. Kapur, S. Chand and company, N. Delhi .
3. **A text Book of Matrices;** Shanti Narayan and P.K. Mittal, S. Chand and Company Ltd.
4. **Fuzhen Zhang, *Matrix theory*,** Springer-Verlag New York, Inc., New York, 1999.
5. **Introductory Method of Numerical Analysis;** S. S. Sastry, Prentice Hall India Pvt. Ltd.
6. **Numerical Mathematical Analysis;** J.B. Scarborough, Oxford & IBH Publishing Co.

GE 2 Analysis II

Total Marks: 100.

Theory: 80; Internal Assessment: 20;

(Credits: Theory-05, Tutorials-01)

5 Lectures, 1 Tutorial (per week)

Theory Classes : 75 , Tutorial Classes : 15

Objectives: Students will be able to identify the analytical aspects of Mathematical concepts.

Real Analysis

Unit-I: Successive differentiation, Leibnitz's theorem, indeterminate forms. Partial Derivatives, Euler's theorem on homogeneous function. **(8 Classes) MARKS:8**

Unit-II: Function of severable variable: Explicit and implicit functions, continuity, partial derivatives, definition of Jacobian, partial derivatives of higher order, Young's and Schwarz's theorem (without proof), change of variables, Taylor's theorem, extreme values.

(10 Classes) MARKS: 10

Integral Calculus

Unit-I: Evaluation of definite integrals by using properties only, Reduction formula of the integrands $\sin^n \theta$, $\cos^n \theta$, $\tan^n \theta$ and $\sin m\theta$, $\cos m\theta$. **(10 Classes) MARKS: 8**

Unit II: Rectification of plane curves. Surface and volume of solids of revolution.

(6 Classes) MARKS: 6

Riemann integral

Definitions and existence of R-integrals, inequalities of R-integrals, refinement and related theorems, Darboux's theorem, conditions of integrability (both the forms), Integral as a limit of sum (Reimann sums) and its relationship with Darboux's condition of integrability, some applications, integrability of continuous and monotonic functions, functions with finite and infinite number of discontinuities, related examples.

Primitive, fundamental theorem (1st & 2nd) of integral calculus, first mean value theorem.

(10 Classes) MARKS: 10

Unit-II: Improper integrals: Introduction and their convergence, Statements of Comparison test, Cauchy's test, Abel's test, Dirichlet's test and their applications. **(7 Classes) MARKS: 8**

Ordinary Differential Equations: (21 Classes)

Unit-I: Differential equation of the type $y' + P(x)y = Q(x)$, Exact differential equations of first order, Equations of first order higher degree, Clairaut's form, wronskian, its properties and application. (8 Classes) Marks: 10

Linear differential equation of higher order with constant coefficients, linear homogeneous equations. (8 Classes) Marks: 10

Unit-II: Linear equation of second order with variable coefficient : Removal of first order derivative. Change of independent variables. Method of variation of parameters. (8 Classes) Marks: 10

Books Recommended

1. **Differential Calculus; B.C. Das and B.N. Mukherjee**, U.N. Dhar and Sons, Private Ltd, Calcutta. 51st edition.
2. **Mathematical Analysis; S.C. Malic, S. Arora**, New Age International (P) Ltd, Third Edition 2007 (reprint) New Delhi.
3. **Integral Calculus including Differential equations; B.C. Das & B.N. Mukherjee**, U.N. Dhar and Sons Pvt. Ltd, Calcutta. 53rd Edition.
4. **Introduction to Real Analysis; R. G. Bartle and D. R. Sherbert** (3rd edition), John Wiley and Sons (Asia) Pvt. Ltd, Singapore, 2002.
5. **Principles of Mathematical Analysis; Walter Rudin**; Mc Graw Hill International.
6. **Mathematical Analysis; Tom M Apostol**, Narosa Publishing House.
7. **Differential Equations; S.C. Ross, John Wiley and sons**, India 2004.
8. **Advance Differential Equation; M.D. Raisinghania**, S. Chand Company.

GE 3: Computational Methods

Total marks: 100; Total credit: 6;

Theory: 65, Practical: 35;

(Credits: Theory-04, Practicals-02)

5 Lectures per week, 2 Practical per week (2 hours practical class)

Theory classes : 60.

Theory classes : 60. E.S.E.-50, I.S.E.-15

Objectives: The students will be able to formulate and solve various practical models using Linear Programming techniques and also by using Computer Laboratory they will attain computational proficiency in dealing with Mathematical Software.

Unit I: LP Model formulation & Graphical Method: Introduction, General structure and assumption of LP model, Mathematical formulation of a linear programming problem, Example of LP model Formulation, Feasible solution, basic solution, graphical method for the solution of a linear programming problem, convex set.

15 Classes Marks : 10

Unit II: Theory of simplex algorithm and simplex method: Standard form of an LP Problem, Simplex Algorithm, Solutions of unique optimal solution, alternative optimal solution, unbounded solution, artificial variable technique (Charnes' M-technique, two phase method), Degeneracy.

20 Classes Marks : 15

Unit III: Matrix inversion methods: Gauss elimination, Gauss Jordan, LU-Decomposition Methods: Crout's method, Doolittle method. Related examples.

10 Classes Marks : 10

Unit IV: Transportation Problem: Definition, Transportation Table, Loops in transportation tables and their properties, Determination of an initial basic feasible solution by North West corner method, Matrix minima or least cost method and Vogel approximation method.

15 Classes Marks : 15

Practical Classes : 30 (2 hours per practical class) E.S.E.-30, I.S.E.-5

Computer Laboratory (Practical)

Matlab / Mathematica: Evaluation of arithmetic expression, exponential and logarithms, trigonometric functions, computation of complex numbers, Plotting of curves (Algebraic function, trigonometric function, and exponential function), Operations in matrices, Plotting of three 3D curves and shapes, Solution of algebraic equation, simultaneous linear equations.

Text Book:

1. **Linear programming and Theory of Game** ; P. M. Karak, New Central Book Agency(P) Ltd
2. **Operation Research – Theory and Application**; J.K.Sharma, McMillan India Ltd. New Delhi.
3. **Getting Started with Matlab: Rudra Pratap, Oxford University Press.**

Reference Books :

1. **Linear Programming**; G. Hadley, Narosa Publishing House.
2. **Linear Programming and Game Theory**; Dipak Chatterjee, Prentice Hall of India (P) Ltd
3. **Linear Programming: R.K. Gupta, Krishna Prakashan Media (P) Ltd.**

GE4: Coordinate Geometry & Abstract Algebra

Total Marks: 100;

Theory: 80; Internal Assessment: 20;

(Credits: Theory-05, Tutorials-01)

5 Lectures, 1 Tutorial (per week)

Objective: The students will be able to get a deeper understanding of geometrical approach through Co-ordinate system and also able to know about preliminary idea about abstract algebra and its application in various fields like chemical structure.

Theory Classes : 75, Tutorial Classes : 15. E.S.E.-80, I.S.E.-20

(A) Co-ordinate Geometry 45 Classes Marks : 50

(a) 2 - Dimension 28 Classes Marks : 35

Unit I: Transformation of coordinates: Translation of axes, Rotation of axes, Invariants, Removal of xy -term. **6 Classes Marks : 10**

Unit II: Pair of straight lines: Pair of straight lines through origin, Angle and Bisectors of the angle between the lines given by homogenous equation of 2nd degree, Condition for the general equation of second degree to represent a pair of straight lines, Pair of intersecting straight lines, Pair of parallel straight lines. **12 Classes Marks : 13**

Unit III: General Equation of second degree: Equation to the conic sections, Centre of a conic, Reduction to central and non central conic, Tangent to the conic and condition of tangency, Chord of contact, Pole and Polar, conjugate diameter, **10 Classes Marks : 12**

(b) 3- Dimension 17 Classes Marks : 15

Unit I: Sphere , Conicoides . **10 Classes Marks : 8**

Unit II: Cylinder & Cone **7 Classes Marks : 7**

(B) Abstract Algebra

30 Classes Marks: 30

Unit-I : Relations : definition & example, Equivalence relations, Equivalence Classes, Binary Compositions.

5 Classes Marks: 5

Unit II : Groups : Definition, Semi group, Subgroup, Normal subgroup, Abelian group, Example and Related Theorem

15 Classes Marks: 15

Unit III : Application of Abstract Algebra , Dihedral groups, group theory in Chemistry.

10 Classes Marks: 10

Text Book:

1. **Analytical Geometry and Vector Analysis**; B. Das, Orient Book Company, Calcutta.
2. **A Course in Abstract Algebra**; V.K.Khanna,S.K.Bhambri, Vikas Publishing house Ltd.

Reference Books :

1. **Analytical Geometry of two and three dimensions**; R.M. Khan, New Central Book Agency, Calcutta
3. **Analytical Geometry of two dimensions**; P K Jain & K. Ahmed, Wiley Eastern Ltd.
2. **Analytical Geometry of three dimensions**; P K Jain & K. Ahmed, Wiley Eastern Ltd
3. **Topics in Algebra**; I.N. Herstein, Wiley India, Pvt.Ltd.
4. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, New Delhi, 1999.

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SEC-1: LaTeX and HTML

Total marks: 50

Theory: 35; Internal Assessment: 15;

(Credits: Theory-01, Practials-01)

2 Lectures + 2 Practical per week

Objective: To train students for effective writing of documents and designing webpages.

Theory Classes : 30

E.S.E.-40, I.S.E.-10

Elements of LaTeX; Hands-on-training of LaTeX; graphics in LaTeX; PSTricks; Beamer presentation; HTML, creating simple web pages, images and links, design of web pages.

[1] Chapter 9-11, 15

Practical : Practical Classes :15.

Six practical should be done by each student. The teacher can assign practical from the exercises from [1].

Text Books:

[1] Martin J. Erickson and Donald Bindner, A Student's Guide to the Study, Practice, and Tools of Modern Mathematics, CRC Press, Boca Raton, FL, 2011.

[2] L. Lamport, LATEX: A Document Preparation System, User's Guide and Reference Manual. Addison-Wesley, New York, second edition, 1994.

SEC 2 Graph Theoretic Modeling

Total marks: 50

Theory: 40; Internal Assessment: 10;

(Credits: Theory-04, Tutorials-01)

2 Lectures, 1 Tutorials (per week)

Objective: Students will be able to understand the fundamentals of graph theory and different representation of graphs.

Theory Classes: 30, Tutorial classes: 15.

E.S.E.-40, I.S.E.-10

Graph Theory: Definition, Directed and undirected graphs, basic terminologies, finite and infinite graph, incidence and degree of vertex, isolated and pendent vertices, null graph, Handshaking theorem, types of graphs, sub graphs, graphs isomorphism, operations of graphs, connected graph, disconnected graphs and components.

Project : Modeling a project on Real life application of Graph theory .

Books Recommended:

Text Books:

1. *Graph Theory with application to Engineering and computer Science*; Narasingh Deo, Prentice Hall of India, New Delhi, 2006.

2. *Graph Theory* by D.B.West

Reference Books :

1. Graph Theory with Application; C. Vasudev, New Age International Publishers.
2. Discrete Mathematics; Swapan Kumar Sarkar, S. Chand & company.