S.S. JAIN SUBODH P.G. COLLEGE

RAM BAGH CIRCLE, JAIPUR-302004

DETAILED COURSE STRUCTURE & SCHEME OF EXAMINATION

AS PER

UGC CURRICULUM AND CREDIT FRAMEWORK FOR UNDERGRADUATE PROGRAMMES UNDER NEP 2020

FOR

BACHELOR OF SCIENCE/ARTS (B.SC. / B.A.)

SUBJECT–MATHEMATICS

(2023-2024 & ONWARDS)

Medium of Instruction: Hindi/ English

Programme outcomes

PO1: Students will acquire basic Practical skills & Technical knowledge along with domain knowledge of different subjects in the science stream.

PO2: Students will become employable; they will be eligible for career opportunities in Industry, or will be able to opt for entrepreneurship.

PO3: Students will possess basic subject knowledge required for higher studies, professional and applied courses like Management Studies, Law etc.

PO4: Students will be aware of and able to develop solution oriented approach towards various Social and Environmental issues.

Programme specific outcomes

PSO1: A student should be able to recall basic facts about mathematics and should be able to display knowledge of conventions such as notations, terminology.

PSO2: A student should get adequate exposure to global and local concerns that explore them many aspects of mathematical sciences.

PSO3: Student is equipped with mathematical modelling ability, problem solving skills, creative talent and power of communication necessary for various kinds of employment.

PSO4: Student should be able to apply their skills and knowledge that is translate information presented verbally into mathematical form, select and use appropriate mathematical formulae or techniques in order to process the information and draw the relevant conclusion.

PSO5: Enabling students to develop a positive attitude towards mathematics as an interesting and valuable subject of study.

Scheme for Choice Based Credit System B.Sc.

NHEQF Level	Course Code	Course Title	Course Category	Credit	Contact Hours per week			ESE Duration (Hrs.)	
					L	T	P	T	P
Semester-I									
5	BSMA101	Differential Calculus	DSC	3	3	-	-	3	-
	BSMA102	Analytic Geometry	DSC	3	3	-	-	3	-
Semester-II									
5	BSMA201	Integral Calculus	DSC	3	3	-	-	3	-
	BSMA202	Abstract Algebra	DSC	3	3	-	-	3	-
Semester-III									
6	BSMA301	Real Analysis	DSC	3	3	-	-	3	-
	BSMA302	Differential Equations	DSC	3	3	-	-	3	-
Semester-IV									
6	BSMA401	Complex Analysis	DSC	3	3	-	-	3	-
	BSMA402	Numerical Analysis	DSC	3	3	-	-	3	-
Semester-V									
7	BSMA501A/BSMA501B	DSE A	DSE	3	3	-	-	3	-
	BSMA502A/BSMA502B	DSE B	DSE	3	3	-	-	3	-
Semester-VI									
7	BSMA601A/BSMA602B	DSE C	DSE	3	3	-	-	3	-
	BSMA602A/BSMA602B	DSE D	DSE	3	3	-	-	3	-

Discipline Subject Elective (DSE)

DSE A (Choose any one)	DSE B (Choose any one)
1. BSMA501A: Advanced Abstract Algebra	1. BSMA502A: Advanced Complex Analysis
2. BSMA501B: Discrete Mathematics	2. BSMA502B: Optimization Theory

DSE C (Choose any one)	DSE D (Choose any one)
1. BSMA601A: Linear Algebra	1. BSMA602A: Mechanics
2. BSMA602B: Graph Theory	2. BSMA602B: Theory of Equations

Scheme for Choice Based Credit System B.A.

NHEQF Level	Course Code	Course Title	Course Category	Credit	Contact Hours per week			ESE Duration (Hrs.)	
					L	T	P	T	P
Semester-I									
5	BAMA101	Differential Calculus	DSC	3	3	-	-	3	-
	BAMA102	Analytic Geometry	DSC	3	3	-	-	3	-
Semester-II									
5	BAMA201	Integral Calculus	DSC	3	3	-	-	3	-
	BAMA202	Abstract Algebra	DSC	3	3	-	-	3	-
Semester-III									
6	BAMA301	Real Analysis	DSC	3	3	-	-	3	-
	BAMA302	Differential Equations	DSC	3	3	-	-	3	-
Semester-IV									
6	BAMA401	Complex Analysis	DSC	3	3	-	-	3	-
	BAMA402	Numerical Analysis	DSC	3	3	-	-	3	-
Semester-V									
7	BAMA501A/BAMA501B	DSE A	DSE	3	3	-	-	3	-
	BAMA502A/BAMA502B	DSE B	DSE	3	3	-	-	3	-
Semester-VI									
7	BAMA601A/BAMA601B	DSE C	DSE	3	3	-	-	3	-
	BAMA602A/BAMA602B	DSE D	DSE	3	3	-	-	3	-

Discipline Subject Elective (DSE)

DSE A (Choose any one)	**DSE B (Choose any one)**
3. BAMA501A: Advanced Abstract Algebra	3. BAMA502A: Advanced Complex Analysis
4. BAMA501B: Discrete Mathematics	4. BAMA502B: Optimization Theory

DSE C (Choose any one)	**DSE D (Choose any one)**
2. BAMA601A: Linear Algebra	3. BAMA602A: Mechanics
2. BAMA601B: Graph Theory	4. BAMA602B: Theory of Equations

Examination Scheme for Each Paper

Part A- Question1 is compulsory comprises eight very short questions (Two from each Unit).

Candidate has to attempt any seven questions. Each question carries 2 marks.

7×2 mark each = 14 Marks

Part B- Comprises 4 questions (one question from each unit with internal choice) and all questions are compulsory. Each Question carries 10 Marks.

4×10 mark each = 40 Marks

Total of End semester exam (duration of exam 3 hours) = 54 Marks

Internal Assessment = 21 Marks

Semester: I

Paper I: Differential Calculus
Course Type: DSC

Prerequisite: Student must know about differentiation and its applications.
Course Objective: The primary objective of this course is to gain proficiency in Differential Calculus and introduce the basic tools which are used to solve application problems in a variety of settings ranging from chemistry and physics to business and economics. Differential calculus develops the concepts of Series, Partial order derivatives, Envelopes and Maxima-Minima and fundamental for various fields of mathematics.

Unit I: Infinite Series: Convergence of series of non-negative terms, their various tests (Comparison; D'Alembert's ratio, Cauchy's n^{th} root, Raabe's, Gauss, Logarithmic, DeMorgan and Bertrand's, Cauchy's condensation (proof of tests not required)) for convergence. Alternating series, Leibnitz's test, Series of arbitrary terms, absolute and conditional convergence.
Unit II: Derivative of the length of an arc, Pedal Equations, Curvature-various formulae, Centre of curvature, Chord of curvature and related problems.
Unit III: Partial differentiation, Euler's Theorem for Homogeneous functions, Chain Rule of Partial Differentiation, Total differential Coefficient, Differentiation of implicit functions.
Unit IV: Envelops, Maxima and Minima of function of two variables, Lagrange's Method of undetermined multipliers.

Course Outcome: On successful completion of this course, Students is able to understand the idea of derivative, tangent line to the graph of a function, how a derivative can be used to describe the rate of change of one quantity with respect to another, and how to relate the geometric ideas to the analytic ideas.

Learner support Material: Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.

Reference Books:

1. MD. Anwarul Haque, 1992 (First Edition), "Calculus of one Variable", New Age International Publication, New Delhi
2. Gupta &Kapoor, 2000 (First Edition), "Text book of differential calculus", S. Chand Publication, New Delhi.
3. A.R. Vasishtha, S.K. Sharma, A. K. Vasishtha, 1989 (First Edition)"Differential Calculus", Krishna Prakashan Media, Meerut.

Online resources: https://www.coursera.org/ , https://www.khanacademy.org/ , https://alison.com/tag/maths

Paper II: Analytic Geometry
Course Type: DSC

Prerequisite: student must know about the basic knowledge of geometry.
Course Objective: The aim of the course is to develop connection between algebra and geometry through graphs of lines and curves.to understand the concept of conic, sphere, cone and central conicoid.

Unit I: Polar equation of conic: General equation of Conic (Focus being the pole), Director Circle, Auxiliary circle, Chord, Tangent, Chord of Contact, Normal, Pole and Polar, perpendicular lines and Asymptotes.
Unit II: Sphere: Equation of sphere, intersection of two spheres, diameter form, tangent line and tangent plane, condition of tangency, pole and polar plane, condition of orthogonality.
Unit III: Cone: Equation of Cone (whose vertex and guiding curve are given), Enveloping cone, right circular cone.
Cylinder: Equation of cylinder, enveloping cylinder, Right circular cylinder.
Unit IV: Central Conicoid: Introduction, Intersection of a line and a Central Conicoid, Tangent line and tangent planes, condition of tangency for a plane. Generating lines of hyperboloid of one sheet and its properties.

Course Outcome: On successful completion of this course, Students will be able to understand the basic applications of coordinate geometry. They will develop ability to pursue advanced studies and research in pure and applied mathematical science.

Learner support Material: Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.

Reference Books:

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, Calculus, John Wiley and Sons (Asia) Pvt. Ltd., 2002.
3. S.L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London.
4. R.J.T. Bill, Elementary Treatise on Coordinate Geometry of Three Dimensions, McMillan India Ltd., 1994.

Online resources: https://www.coursera.org/ , https://www.khanacademy.org/ , https://alison.com/tag/maths

Semester: II

Paper I: Integral Calculus

Course Type: DSC

Prerequisite: Student must know about integration and its properties.

Course Objective: The primary objective of this course is to gain proficiency in Integral Calculus. The objectives of this course are to consider applications of derivatives for sketching of curves, concept of Double and Triple integral, application of definite integrals for calculating volumes of solids of revolution, length of plane curves, Areas which are helpful in understanding their applications in planetary motion, design of telescope and to many real-world problems.

Unit I: Asymptotes, Multiple points, Curve tracing of standard curves (Cartesian and polar curves).

Unit II: Introduction of Beta and Gamma functions. Double integrals in Cartesian and polar coordinates. Change of order of integration (Cartesian and polar coordinates).

Unit III: Triple integrals, Dirichlet's Integration, Rectification.

Unit IV: Areas, Volumes and surfaces of solids of revolution.

Course Outcome: On successful completion of this course, Students will enable to sketch curves in a plane using its mathematical properties in the different coordinate systems of reference. Student will able to compute the length of curve, area bounded by the curves, area and volume of surface of solid of revolution.

Learner support Material: Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.

Reference Books:

1. Anton, Howard, Bivens, Irl, & Davis, Stephen, Calculus (10th Ed.), John Wiley & Sons Singapore Pvt. Ltd. Reprint (2016) by Wiley India Pvt. Ltd. Delhi.
2. Strauss, M. J., Bradley, G. L., & Smith, K. J. (2007). Calculus (3rd Ed.). Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi. Sixth impression 2011.
3. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.

Online resources: https://www.coursera.org/ , https://www.khanacademy.org/ , https://alison.com/tag/maths

Paper II: Abstract Algebra
Course Type: DSC

Prerequisite: The student must know the basic knowledge of set, relation and functions.
Course Objective: The main aim of the course is to introduce you to basic concepts from abstract algebra, especially the notion of a group. The Abstract Algebra module focuses on the power of abstraction by developing mathematical theories from axioms in several contexts – Group Theory, Rings and Fields.

UNIT I: Definition and simple properties of Groups and subgroup, cyclic group, Permutation group. Cosets, Lagrange's theorem on the order of subgroups of a finite order group.
UNIT II: Normal subgroups and Quotient groups. Morphism of groups, Fundamental theorems of Isomorphism, Cayley's theorem.
UNIT III: Definition and simple properties of Rings, Integral domain and field.
UNIT IV: Characteristics of a Ring and Field, Sub rings, Subfield, Embedding of a ring, Morphism of rings.

Course Outcome: The students who succeeded in this course; will able construct and compare algebraic structures and substructures and analyze a given structure in detail. They also understand a new structure based on given structures.

Learner support Material: Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.

Reference Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
4. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
5. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.
6. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
7. D.A.R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998

Online resources: https://www.coursera.org/, https://www.khanacademy.org/, https://alison.com/tag/maths.

Semester: III

Paper I: Real Analysis
Course Type: DSC

Prerequisite: The student must know the basic knowledge of real number system.
Course Objective: The course will develop a deeper and more rigorous understanding of defining terms and proving results about convergence of sequences of real numbers, Concept of compactness, concepts of Limit Continuity and Differentiability, Riemann integration and Uniform convergence having wide applications in real-world problems.

Unit I: Limit point, Bolzano-Weierstrass Theorem, Closed and open sets, union and intersection of open and closed sets, concept of compactness, Heine-Borel Theorem, Connected sets. Real sequence-Limit and Convergence of a sequence, Monotonic sequences, Cauchy's Sequences.

Unit II: Subsequence, Cauchy's general Principle of convergence. Notion of Limit, Continuity, Properties of continuous function on closed intervals. Limit and Continuity on functions of two variables.

Unit III: Differentiability, Properties of derivable functions, Darboux's and Roll's Theorem. Riemann Integration–Lower and upper Riemann integral, Definition of Riemann Integration, Integrability of Continuous functions.

Unit IV: Sequence and series of functions-Pointwise and Uniform Convergence, Cauchy's Criterion, M_n Test, Weiertrass M-Test, Abel's Test, Drichlet's test for Uniform Convergence of sequence and series of functions.

Course Outcome: On successful completion of this course, Students

1. Describe fundamental properties of the real numbers that lead to the formal development of real analysis.
2. Comprehend regions arguments developing the theory underpinning real analysis
3. Demonstrate an understanding of limits ad how that is used in sequences, series and differentiation.
4. Construct rigorous mathematical proofs of basic results in real analysis.
5. Appreciate how abstract ideas and regions methods in mathematical analysis can be applied to important practical problems.

Learner support Material: Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.

Reference Books

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

Online resources: https://www.coursera.org/, https://www.khanacademy.org/, https://alison.com/tag/maths.

Paper II: Differential Equations
Course Type: DSC

Prerequisite: The student must know the basic knowledge of differential equation.
Course Objective: This course helps the students to develop skills and knowledge of standard concepts in ordinary and partial differential equations and also provide the standard methods for solving differential equations.

Unit I: Differential Equations of first order and first degree: Exact Differential Equations and equations which can be made exact. First order but higher degree differential equations, solvable for x, y and p. Clairaut's form and singular solutions with extraneous loci.

Unit II: Second Order Linear differential equation with constant coefficients, complementary functions, particular integral. Homogeneous Linear differential Equation.

Unit III: Exact Linear Differential Equation of Higher order. Second Order Linear Differential Equation with Variable Coefficient, Linear Independence of solutions, Solution by transformation of the equations by changing the dependent variable/ independent variables, Method of Variation of parameters.

Unit IV: Partial Differential Equations of first order, Lagrange's Linear Equation, Charpit's Method. Homogeneous and non-homogeneous Linear Partial Differential Equations with constant coefficients.
Course Outcome: On successful completion of this course, Students will be able to

1. Distinguish between linear, nonlinear, partial and ordinary differential equations.
2. Recognize and solve exact differential equation by use of an integrating factor.
3. Solve basic application problems described by first and second order differential equations

Learner support Material: Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.

Reference books:

1. D.W. Jordan &P.Smith, "Mathematical Techniques", Oxford University Press.
2. M.D. Raisinghania, "Differential Equation", S Chand Publication, New Delhi.
3. RakeshAgarwal, "Engineering Mathematics" Vayu Education of India, New Delhi.
4. Gupta, Malik, Mittal, "Differential Equations", Pragti Prakashan, Meerut.
5. Bansal and Dhami, Volume I , II, "Differential Equations", Jaipur Publishing House, Jaipur.
6. M. Roy and J.C Chaturvedi, "A text Book of Differential equations", Student Friends and Co. Publisher, Agra.
7. TynMyint-U and Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint.

Online Resources: https://www.coursera.org/, https://www.khanacademy.org/, https://alison.com/tag/maths.

Semester: IV

Paper I: Complex Analysis
Course Type: DSC

Prerequisite: The student must know the basic knowledge of complex variables and real analysis.

Course Objective: This course aims to introduce the basic ideas of analysis for complex functions in complex variables. Particular emphasis has been laid on Analytic Function, Conformal Mapping, Bilinear Transformation and Complex Integration.

UNIT I: Complex plane, Connected and Compact sets, Curves and Regions in complex plane. Jordan Curve Theorem (statement only), Extended complex plane, Stereographic projection, Complex valued function-Limits, Continuity and Differentiability.
UNIT II: Analytic functions, Cauchy-Riemann equations (Cartesian and polar form), Harmonic functions, Construction of an analytic function.
UNIT III: Conformal mapping. Bilinear transformation and its properties. Elementary mappings: $f(z) = \frac{1}{z}, z + \frac{1}{z}, z^2, sinz, cosz, logz.$
UNIT IV: Complex integration, Complex line integrals, Cauchy integral theorem, Indefinite integral, Fundamental theorem of integral calculus for complex functions. Cauchy integral formula, Analyticity of the derivative of an analytic function, Morera's theorem, Poisson integral formula.

Course Outcome: The student is able to

1. Know the central importance of complex variables in analysis.
2. Grasped a deeper understanding of differentiation and integration in this setting
3. Know the tools and results of complex analysis including Cauchy's Theorem, Cauchy's integral formula

Learner support Material: Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.

Reference Books:

1. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed., McGraw – Hill International Edition, 2009.
2. Joseph Bak and Donald J. Newman, Complex Analysis, 39 2nd Ed., Undergraduate Texts in Mathematics, Springer Verlag New York, Inc., NewYork, 1997.

Online resources: https://www.coursera.org/, https://www.khanacademy.org/, https://alison.com/tag/maths.

Paper II: Numerical Analysis
Course Type: DSC

Prerequisite: The student must know the basic knowledge of scientific calculator and numerical solutions.
Course Objectives: To comprehend various computational techniques as interpolation for equal and unequal intervals, techniques to find in approximate value for possible root(s) of non-algebraic equations, to find the approximate solutions of system of linear equations and ordinary differential equations, Numerical differentiation. The use of these numerical techniques enhances the problem solving skills of students.

Syllabus:
Unit I: Introduction of forward and backward differences, Interpolation with equal interval: Newton's Formula for Forward and Backward interpolation. Interpolation with unequal interval: Divided Differences, Newton's Divided difference interpolation formula, Lagrange's Interpolation Formula.
Unit II: Central Differences: Gauss's forward and backward Formula, Sterling Formula, Bessel's formula, Numerical Differentiation and Integration, Trapezoidal Rule, Simpson's 1/3 and 3/8 Rule.
Unit III: Numerical Solutions of algebraic and Transcendental Equations, Method of Iteration, Bisection Method, Secant method, Regula-Falsi Method, Newton-Raphson Method. Gauss Elimination and Iterative Method (Jacobi and Gauss-Seidal Method) for solving system of linear algebraic simultaneous equations.
Unit IV: Numerical Solutions of differential equations, Initial value and boundary value problem, Picard's method, Euler's Method, Modified Euler Method, Third and fourth order Runge-Kutta Methods.

Course Outcome: Students are able to
1. Understand the nature and operations of Numerical Analysis, demonstrate familiarity with theories and concepts used in Numerical Analysis
2. Identify the steps required to carry out a piece of research on a topic in Numerical Analysis,
3. Apply Numerical Methods to solve algebraic and transcendental equations, integrals and differential equations.
4. Study their convergence rate and performance, applicability of the methods on different test examples.
5. Recognize and apply appropriate theories, principles and concepts relevant to Numerical Analysis.

Learner support Material: Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.
Reference Books:

1. Brian Bradie,A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Ed., New age International Publisher, India, 2007.
3. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.
4. Bansal& Ojha, 1989 (First Edition), "Numerical Analysis" JPH Publication, Jaipur.
5. S S Shastri, 2003 (First Edition), " Numerical Analysis", New Age Publication, New Delhi.

Online resources: https://www.coursera.org/, https://www.khanacademy.org/, https://alison.com/tag/maths.

Semester: V

DSE A: Advanced Abstract Algebra
Course Type: DSE

Prerequisite: The student must study the Abstract Algebra of II Semester.

Course Objective: This course introduces the basic concepts of Ideals, Quotient ring and Vector Space.

UNIT I: Ideals and Quotient Ring, Maximal ideal and Prime ideal, Principal Ideal domain.

UNIT II: Field of quotients of an integral domain, Prime fields. Vector spaces and Subspaces: Definitions, Examples and its simple properties.
UNIT III: Vector Space: Linear combination, Linear dependence and Linear independence of vectors. Basis and Dimension, Generation of subspaces. Sum of subspaces. Direct sum and Complement of subspaces
UNIT IV: Quotient space and its dimension, Linear Transformation and its simple properties, Kernel of Linear transformation.

Course Outcome: The students who succeeded in this course; will able to understand the concept of ideals, field of quotient, vector space, basis, dimension and quotient space.

Learner support Material: Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.

Reference Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
4. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
5. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.
6. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
7. D.A.R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998

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DSE A: Discrete Mathematics
Course Type: DSE

Prerequisite: student must know about Set, Relation and Function.
Course Objective: This course aims at introducing the concepts of lattices, Boolean algebras, switching circuits and recurrence relation. The course discusses some important applications of Boolean algebra in real life situations.

Unit I: Sets: Principle of inclusion and exclusion, Russell Paradox and Mathematical Induction. Propositional calculus, Basic logical Proposition, truth table, Tautologies and contradiction.
Unit II: Relations and Functions: Binary Relations, Equivalence Relations and Partitions. Partial and total Order Relations, Lattices and algebraic structure. Chains and Anti-chains. Pigeon Hole Principle.
Unit III: Boolean algebras: Boolean functions and expressions (Using Identity / Truth table), conjunctive and disjunctive normal form, Duality, Boolean Lattices.
Unit IV: Discrete numeric Function and Generating Function, Recurrence Relations and recursive algorithm-Linear recurrence relations with constant coefficients. Homogeneous solutions, particular solution, Total solution, Solution by the method of generating functions.

Course Outcome: After completion of the course students are expected to be able to:
1. Analyze logical propositions via truth tables.
2. Prove mathematical theorems using mathematical induction.
3. Understand sets and perform operations and algebra on sets.
4. Determine properties of relations, identify equivalence and partial order relations, sketch relations.
5. Identify functions and determine their properties.

Reference Books:

1. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory 2nd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2003.
2. Rudolf Lidl and Günter Pilz, Discrete Mathematics: Elementary and Beyond, 2003.

Learner support Material: Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.

Online resources: https://www.coursera.org/, https://www.khanacademy.org/, https://alison.com/tag/maths

DSE B: Advanced Complex Analysis
Course Type: DSE

Prerequisite: The student must study the Complex Analysis of IV Semester.
Course Objective: This course aims to provide knowledge of power series, singularities, various theorems and their applications.

UNIT I: Power series-Absolute convergence, Abel's theorem, Cauchy-Hadamard theorem. Circle and Radius of convergence, Analyticity of the sum function of a power series, Analytic continuation. Power series method of analytic continuation.
UNIT II: Liouville's theorem, Taylor's theorem. Laurent's theorem, Maximal modulus theorem and Applications of these theorems.
UNIT III: Singularities of an analytic function, Riemann's theorem, Casorati-Weierstrass theorem, Residue at a singularity, Cauchy's residue theorem.
UNIT IV: Branch point, Meromorphic and Entire functions, Argument Principle. Rouche's theorem, Fundamental theorem of Algebra, Evaluation of a real definite integral by contour integration.

Course Outcome: After successful completion of this paper, student will able to understand the manipulation skills in the use of Rouche's theorem, Cauchy-Hadamard theorem, radius of convergence, Argument Principle, the principle of Analytic Continuation and the concerned results.

Reference Books:

1. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications (Eighth Edition), McGraw – Hill International Edition, 2009.
2. Joseph Bak and Donald J. Newman, Complex analysis (2nd Edition), Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.

Learner support Material: Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.

Online resources: https://www.coursera.org/, https://www.khanacademy.org/, https://alison.com/tag/maths.

DSE B: Optimization Theory
Course Type: DSE

Prerequisite: Student should know about the basic knowledge of Set Theory and Matrix.

Course Objective: The main objective of this course is to gain proficiency in the field of optimization theory. The objectives of this course to understand the solution of linear programming problems and engineering problems related to Assignment and Transportation problems with applications of many real-world problems

Unit I: Linear programming problem formulation. L.P.P. matrix notation, Basic solution, some basic properties of convex sets, Theorems based on convex sets.
Unit II: Fundamental theorem of L.P.P. Simplex method (Phase-I) for solution of a L.P.P.
Unit III: Duality: Fundamental theorem, properties of duality and Simple Problems of Duality.
Unit IV: Modelling of Industry and engineering problems into Assignment and Transportation problems and their solution.

Course Outcome: On successful completion of this course students are able to understand the linear optimization theory and its applications. Student can identify the appropriate methods for the efficient computation of optimal solutions of a problem and a set of linear constraints.

Learner support Material: Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.

Reference books:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 8th Ed., Tata McGraw Hill, Singapore, 2004.
3. Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006.

Online resources: https://www.coursera.org/ , https://www.khanacademy.org/ , https://alison.com/tag/maths

Semester: VI

DSE C: Linear Algebra
Course Type: DSE

Prerequisite: Student should know about the basic knowledge of vector space.
Course Objective: The objective of this course is to introduce the fundamentals of linear algebra.

UNIT I: Linear Transformations, Nullity and rank, Sylvester Law of Nullity, Singular and nonsingular transformations, linear operator, invertible operator, quotient transformation.
UNIT II: Matrix Algebra, Matrix representation of transformation, Matrix representation of linear operators, Change of Basis, Similar matrices, Similarity of Linear map, determinant of a map.
Unit III: Dual Space, Linear functional, dual basis, Natural Mapping and reflexivity, Annihilator, Transpose of a linear map.
UNIT IV: Bilinear form, Symmetric and antisymmetric forms, quadratic form, matrix representation, degenerate and non-degenerate form, Projection and Invariance.

Course Outcome: After studying this course, you should be able to understand the concepts of linear transformation and their properties, Matrix representation of transformation, Dual Basis and bilinear forms.

Reference Books:

1. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra (4th Edition), Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
2. Joseph A. Gallian, Contemporary Abstract Algebra (4th Edition), Narosa Publishing House, New Delhi, 1999.
3. S Lang, Introduction to Linear Algebra (2nd edition), Springer, 2005 2. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007
4. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.
5. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra 2nd Ed., Prentice-Hall Of India Pvt. Limited, 1971

Learner support Material: Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.

Online resources: https://www.coursera.org/, https://www.khanacademy.org/, https://alison.com/tag/maths.

DSE C: Graph Theory
Course Type: DSE

Prerequisite: The student must know the basic knowledge of set, relation and function.
Course Objective: The course aims at introducing the concepts of types of graphs, Paths and circuits. It also includes introduction to Digraph and Binary Relations, some operations of graphs. Then some important concept of Trees explained. The other part of the course deals with planar graphs and matrix representation also.

Unit I: Graph Theory- simple graph, Multi graph, properties of graph, Degree of Vertex, Directed Graph, Undirected Graph, Digraph and binary relation, Regular graph, n-Regular graph, size of n-Regular graph, Sub Graphs, Complete Graph, Cycles, wheels, Bipartite graph, Matrix representation of Graph and Digraph.
Unit II: Union, Join, Product, and composition of graphs, Complementary graph, Isomorphic graph, Cut sets, bridge, edge connectivity, vertex connectivity, Connected and disconnected graphs, Seperable graph, walk, open and closed walk, length of walk, Trail, Path, Circuit, Euler path, Euler graph, Hamiltonian cycle and path, Hamilton Graph.
Unit III: Weighted graph, Shortest path problem, Planar & non-Planar Graph and its properties, region, degree of region, Euler's formula, Homeomorphic graph and Dual graphs.
Unit IV: Trees- Properties, Distance between two vertices, eccentricity of vertex, centre of a graph, Rooted Tree, Binary Tree, Height of a tree, Balanced rooted tree, Spanning Tree, Minimal Spanning Tree: Kruskal's Algorithm and Prim's Algorithm.

Course Outcome: The students will be able to

1. Understand the basics of graph theory and their various properties.
2. Model problems using graphs and to solve these problems algorithmically.
3. Apply graph theory concepts to solve real world applications like routing, TSP/traffic control, etc.

Learner support Material: Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.

Reference Books:

1. Davey, B. A., & Priestley, H. A. (2002). Introduction to Lattices and Order (2nd Ed.). Cambridge University press, Cambridge.
2. Goodaire, Edgar G., & Parmenter, Michael M. (2011). Discrete Mathematics with Graph Theory (3rd ed.). Pearson Education (Singapore) Pvt. Ltd. Indian Reprint.
3. Lidl, Rudolf & Pilz, Gunter. (2004). Applied Abstract Algebra (2nd ed.), Undergraduate Texts in Mathematics. Springer (SIE). Indian Reprint.

Online resources: https://www.coursera.org/, https://www.khanacademy.org/, https://alison.com/tag/maths.

DSE D: Mechanics
Course Type: DSE

Prerequisite: The student must know the basic knowledge of dynamics.
Course Objective: This course helps the students to develop skills and knowledge of standard concepts in mechanics and to become aware of their applications. The course aims at understanding the various concepts of Kinematics, Motion, Central orbits and coplanar forces. It emphasizes knowledge building for applying mathematics in physical world.

Unit I: Kinematics: Velocity and acceleration-along radial and transverse directions, along tangential and normal directions. Simple Harmonic Motion. Hooke's law, Motion along horizontal and vertical elastic strings.
Unit II: Motion in resisting medium- Resistance varies as velocity and square of velocity. Projectile Motion, Time motion of Projectile and its trajectory, Projection pass through a given point.
Unit III: Motion on a smooth curve in a vertical plane. Motion on the inside of a smooth vertical circle. Central orbits p-r equations.
Unit IV: Coplaner Forces, General conditions of equilibrium of rigid body under several coplanar forces. Common Catenary.

Course Outcome: Student will be able to:

1. Learn about concept of Velocity and Acceleration.
2. Understand the theory of Simple Harmonic Motion and Hooke's law and Motion of elastic strings.
3. Know about various topics in dynamics such as Motion in resisting medium and Projectile motion.
4. Learn the concept of motion on smooth curve in vertical plane and inside the circle also.
5. Demonstrate about coplanar forces and Catenary.

Learner support Material: Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
Reference Books:

1. I.H. Shames and G. Krishna Mohan Rao, Engineering Mechanics: Statics and Dynamics, (4th Ed.), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.
2. R.C. Hibbeler and Ashok Gupta, Engineering Mechanics: Statics and Dynamics, 11th Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi.

Online Resources: https://www.coursera.org/, https://www.khanacademy.org/, https://alison.com/tag/maths.

DSE D: Theory of Equations
Course Type: DSE

Prerequisite: The student must know the basic knowledge of algebraic equation and its roots.
Course Objective: The goal of this paper is to acquaint students with certain ideas about the general properties of roots of polynomial equations with some applications

Unit I: General properties of polynomials, Graphical representation of polynomials, maximum and minimum values of polynomials, General properties of equations.
Unit II: Descarte's rule of signs positive and negative rule, Relation between the roots and the coefficients of equations. Symmetric functions, Applications symmetric function of the roots.
Unit III: Transformation of equations. Solutions of reciprocal and binomial equations.
Unit IV: Algebraic solutions of the cubic and biquadratic. Cardon and Ferrari method, Properties of the derived functions.

Course Outcome: After completion of this paper, the students will be able to understand the properties of roots of polynomial 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.

Learner support Material: Swayam (https://swayam.gov.in), E-library, E-books, online PDF material etc.

Online resources: https://www.coursera.org/, https://www.khanacademy.org/, https://alison.com/tag/maths.