Programme Name: B.A. with Mathematics

Programme Outcomes

- Inculcate critical thinking to carry out scientific investigation objectively without being biased with preconceived notions.
- Equip the student with skills to analyze problems, formulate a hypothesis, evaluate and validate results, and draw reasonable conclusions thereof.
- Prepare students for pursuing research or careers in industry in mathematical sciences and allied fields
- Imbibe effective scientific and/or technical communication in both oral and writing.
- Continue to acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in mathematical sciences.
- Create awareness to become an enlightened citizen with commitment to deliver one's responsibilities within the scope of bestowed rights and privileges.
- To find employment utilizing their mathematical knowledge.

Programme Specific Outcomes

By the end of a degree program a student will:

- have Understanding of the fundamental axioms in mathematics and capability of developing ideas based on them.
- able to inculcate mathematical reasoning.
- on completion of the program the students are well poised to pursue M.sc. in Mathematics.
- able to apply critical thinking skills to solve problems that can be modeled mathematically.
- have an appreciation of how various sub-disciplines of mathematics are related.
- understand the concepts of algebra which include equations, numbers and algebraic structures.
- students will be able to use the concepts of analysis in solving problems. The concepts include sets, numbers, functions and convergence.

Algebra

Paper BM 111 **Time:3 hours** **Max. Marks: 27**

Note: The question paper will consist of five sections. Each of the first four sections(I-IV) will contain two questions(each carrying 4.5 marks) and the students shall be asked to attempt one question from each section. Section-V will contain six short answer type questions (each carrying 1.5 marks) without any internal choice covering the entire syllabus and shall be compulsory.

Section – I Symmetric, Skew symmetric, Hermitian and skew Hermitian matrices. Elementary Operations on matrices, Rank of a matrices. Inverse of a matrix. Linear dependence and independence of rows and columns of matrices. Row rank and column rank of a matrix. Eigenvalues, eigenvectors and the characteristic equation of a matrix. Minimal polynomial of a matrix. Cayley Hamilton theorem and its use in finding the inverse of a matrix.

Section – II Applications of matrices to a system of linear (both homogeneous and non–homogeneous) equations. Theorems on consistency of a system of linear equations. Unitary and Orthogonal Matrices, Bilinear and Quadratic forms.

Section – III Relations between the roots and coefficients of general polynomial equation in one variable. Solutions of polynomial equations having conditions on roots. Common roots and multiple roots. Transformation of equations.

Section – IV : Nature of the roots of an equation Descarte's rule of signs. Solutions of cubic equations (Cardon's method). Biquadratic equations and their solutions.

Books Recommended :

1. H.S. Hall and S.R. Knight : Higher Algebra, H.M. Publications 1994.
2. Shanti Narayan : A Text Books of Matrices.
3. Chandrika Prasad : Text Book on Algebra and Theory of Equations. Pothishala Private Ltd., Allahabad.

Course Outcome: Algebra

By the end of a course a student will:

CO1 : have knowledge about the concept of different type of matrices. Binomial and Exponential series

CO2 : Develop skills for solving equations

CO3: have a clear knowledge regarding relations between roots and coefficients of general polynomial equation

CO4: be able to implement different methods to find roots of cubic and biquadratic equations

Calculus

Paper code: BM 112 **Time: 3Hours** **Max. Marks:** 27

Note: The question paper will consist of five sections. Each of the first four sections (I-IV) will contain two questions (each carrying 4.5 marks) and the students shall be asked to attempt one question from each section. Section-V will contain six short answer type questions (each carrying 1.5 marks) without any internal choice covering the entire syllabus and shall be compulsory.

Section – I Definition of the limit of a function, Basic properties of limits, Continuous functions and classification of discontinuities. Differentiability., Successive differentiation. Leibnitz theorem, Maclaurin's and Taylor series expansions.

Section – II Asymptotes in Cartesian coordinates, intersection of curve and its asymptotes, asymptotes in polar coordinates. Curvature, radius of curvature for Cartesian curves, parametric curves, polar curves. Newton's method. Radius of curvature for pedal curves. Tangential polar equations, Centre of curvature. Circle of curvature. Chord of curvature, evolutes. Tests for concavity and convexity. Points of inflexion. Multiple points. Cusps, nodes & conjugate points. Type of cusps.

Section – III : Tracing of curves in Cartesian, parametric and polar co-ordinates. Reduction formulae. Rectification, intrinsic equations of curve.

Section – IV : Quardrature (area)Sectorial area. Area bounded by closed curves. Volumes and surfaces of solids of revolution. Theorems of Pappu's and Guilden.

Books Recommended :

1. Differential and Integral Calculus : Shanti Narayan.
2. Murray R. Spiegel : Theory and Problems of Advanced Calculus. Schaun's Outline series. Schaum Publishing Co., New York.
3. N. Piskunov : Differential and integral Calculus. Peace Publishers, Moscow.
4. Gorakh Prasad : Differential Calculus. Pothishasla Pvt. Ltd., Allahabad.

Course outcomes: Calculus

By the end of a course a student will be able to:

CO1: identify areas in mathematics and other fields where Calculus is useful

CO2: interpret a function from an algebraic, numerical, graphical and verbal perspective and extract information relevant to the phenomenon modeled by the function.

CO3: understand the consequences of the intermediate value theorem for continuous functions

CO4: identify the extrema of a function on an interval and classify them as minima , maxima or saddles using the first derivative test.

CO5: understand the consequences of Leibnitz theorem, Maclaurin’s, Taylor series expansions and Theorems of Pappu’s and Guilden..

CO6: concepts of curvature, evolutes and envelopes of certain curves.

CO7: Trace curves in Cartesian, parametric and polar co-ordinates.

CO8: Find Length of arc of curve and area/ sectorial area for curve.

Solid Geometry

Paper: BM 113 **Time:3 hours** **Max. Marks: 26**

Note: The question paper will consist of five sections. Each of the first four sections (I-IV) will contain two questions (each carrying 5 marks) and the students shall be asked to attempt one question from each section. Section-V will contain six short answer type questions (each carrying 1) without any internal choice covering the entire syllabus and shall be compulsory.

Section – I : General equation of second degree. Tracing of conics. Tangent at any point to the conic, chord of contact, pole of line to the conic, director circle of conic. System of conics. Confocal conics. Polar equation of a conic, tangent and normal to the conic.

Section – II : Sphere: Plane section of a sphere. Sphere through a given circle. Intersection of two spheres, radical plane of two spheres. Co-oxal system of spheres. Cones. Right circular cone, enveloping cone and reciprocal cone. Cylinder: Right circular cylinder and enveloping cylinder.

Section – III : Central Conicoids: Equation of tangent plane. Director sphere. Normal to the conicoids. Polar plane of a point. Enveloping cone of a coincoid. Enveloping cylinder of a coincoid.

Section – IV : Paraboloids: Circular section, Plane sections of conicoids. Generating lines. Confocal conicoid. Reduction of second degree equations.

Books Recommended

1. R.J.T. Bill, Elementary Treatise on Coordinary Geometry of Three Dimensions, MacMillan India Ltd. 1994.
2. P.K. Jain and Khalil Ahmad : A Textbook of Analytical Geometry of Three Dimensions, Wiley Eastern Ltd. 1999

Course outcomes: Solid Geometry

By the end of a course a student will:

CO1 : have knowledge about coordinate geometry and tracing of conic

CO2 : have a clear knowledge regarding sphere, cone and cylinder.

CO3 : be able to define an idea about regular geometrical figures of central conicoids and their properties.

CO4: have thorough knowledge regarding generating lines and confocal conicoid planes.

Number Theory and Trigonometry

Paper code: BM 121 **Time: 3 Hours** **Max. Marks: 27**

Note: The question paper will consist of five sections. Each of the first four sections(I-IV) will contain two questions(each carrying 4.5 marks) and the students shall be asked to attempt one question from each section. Section-V will contain six short answer type questions(each carrying 1.5 marks) without any internal choice covering the entire syllabus and shall be compulsory.

Section – I : Divisibility, G.C.D.(greatest common divisors), L.C.M.(least common multiple) Primes, Fundamental Theorem of Arithemetic. Linear Congruences, Fermat's theorem. Wilson's theorem and its converse. Linear Diophanatine equations in two variables

Section – II : Complete residue system and reduced residue system modulo m. Euler's ø function Euler's generalization of Fermat's theorem. Chinese Remainder Theorem. Quadratic residues. Legendre symbols. Lemma of Gauss; Gauss reciprocity law. Greatest integer function [x]. The number of divisors and the sum of divisors of a natural number n (The functions d(n) and σ(n)). Moebius function and Moebius inversion formula.

Section - III : De Moivre's Theorem and its Applications. Expansion of trigonometrical functions. Direct circular and hyperbolic functions and their properties.

Section – IV : Inverse circular and hyperbolic functions and their properties. Logarithm of a complex quantity. Gregory's series. Summation of Trigonometry series.

Books Recommended :

1. S.L. Loney : Plane Trigonometry Part – II, Macmillan and Company, London.
2. R.S. Verma and K.S. Sukla : Text Book on Trigonometry, Pothishala Pvt. Ltd. Allahabad.
3. Ivan Ninen and H.S. Zuckerman. An Introduction to the Theory of Numbers.

Course outcomes: Number Theory and Trigonometry

By the end of a course a student will be able to:

CO1: Understand of the basic structures of number theory: define terms, explain their significance, and apply them in context.

CO2: Demonstrate knowledge and understanding of topics including, but not limited to divisibility, prime numbers, congruences, quadratic reciprocity, Diophantine equations.

CO3: Define Inverse circular and hyperbolic functions, their properties. Logarithm of a complex quantity.

CO4: define complete residue system, reduced residue system modulo m and Quadratic residues and solve related problems.

CO5: Define and solve problems for Greatest integer function [x], d(n), σ(n) and Moebius function

CO6: Solve problems using De Moivre's Theorem along with their application.

Ordinary Differential Equations

Paper: BM 122 **Time: 3 Hours** **Max. Marks: 27**

Note: The question paper will consist of five sections. Each of the first four sections(I-IV) will contain two questions(each carrying 4.5 marks) and the students shall be asked to attempt one question from each section. Section-V will contain six short answer type questions(each carrying 1.5 marks)without any internal choice covering the entire syllabus and shall be compulsory.

Section – I : Geometrical meaning of a differential equation. Exact differential equations, integrating factors. First order higher degree equations solvable for x,y,p Lagrange's equations, Clairaut's equations. Equation reducible to Clairaut's form. Singular solutions.

Section – II : Orthogonal trajectories: in Cartesian coordinates and polar coordinates. Self orthogonal family of curves. Linear differential equations with constant coefficients. Homogeneous linear ordinary differential equations. Equations reducible to homogeneous.

Section – III : Linear differential equations of second order: Reduction to normal form. Transformation of the equation by changing the dependent variable/ the independent variable. Solution by operators of non-homogeneous linear differential equations. Reduction of order of a differential equation. Method of variations of parameters. Method of undetermined coefficients.

Section – IV : Ordinary simultaneous differential equations. Solution of simultaneous differential equations involving operators x (d/dx) or t (d/dt) etc. Simultaneous equation of the form dx/P = dy/Q = dz/R. Total differential equations. Condition for Pdx + Qdy +Rdz = 0 to be exact. General method of solving Pdx + Qdy + Rdz = 0 by taking one variable constant. Method of auxiliary equations.

Books Recommended :

1. D.A. Murray : Introductory Course in Differential Equations. Orient Longaman (India) . 1967
2. A.R.Forsyth : A Treatise on Differential Equations, Machmillan and Co. Ltd. London
3. E.A. Codington : Introduction to Differential Equations.
4. S.L.Ross: Differential Equations, John Wiley & Sons
5. B.Rai & D.P. Chaudhary : Ordinary Differential Equations; Narosa, Publishing House Pvt. Ltd

Course outcome: **Ordinary Differential Equations**

By the end of a course a student will:

CO1 : Understands the geometry mean of Differential Equations and Classify various methods in solving Differential Equations.

CO2: have knowledge of concept of Orthogonal trajectories: in Cartesian coordinates and polar coordinates.

CO3: be able to solve Linear differential equations with constant coefficients.

CO4: be able to describe the different methods to solve Linear differential equations of second order.

CO5: be able to solve Ordinary simultaneous differential equations

Vector Calculus

Paper: BM 123 **Time: 3 Hours** **Max. Marks: 26**

Note: The question paper will consist of five sections. Each of the first four sections(I-IV) will contain two questions (each carrying 5 marks) and the students shall be asked to attempt one question from each section. Section-V will contain six short answer type questions (each carrying 1 marks) without any internal choice covering the entire syllabus and shall be compulsory.

Section – I Scalar and vector product of three vectors, product of four vectors. Reciprocal vectors. Vector differentiation. Scalar Valued point functions, vector valued point functions, derivative along a curve, directional derivatives

Section – II Gradient of a scalar point function, geometrical interpretation of grad) , character of gradient as a point function. Divergence and curl of vector point function, characters of Div f & and Curl f & as point function, examples. Gradient, divergence and curl of sums and product and their related vector identities. Laplacian operator.

Section – III Orthogonal curvilinear coordinates Conditions for orthogonality fundamental triad of mutually orthogonal unit vectors. Gradient, Divergence, Curl and Laplacian operators in terms of orthogonal curvilinear coordinates, Cylindrical co-ordinates and Spherical co-ordinates.

Section – IV Vector integration; Line integral, Surface integral, Volume integral. Theorems of Gauss, Green & Stokes and problems based on these theorms.

Books Recommended:

1. Murrary R. Spiegal : Theory and Problems of Advanced Calculus, Schaum Publishing Company, New York.
2. Murrary R. Spiegal : Vector Analysis, Schaum Publisghing Company, New York.
3. N. Saran and S.N. NIgam. Introduction to Vector Analysis, Pothishala Pvt. Ltd., Allahabad.
4. Shanti Narayna : A Text Book of Vector Calculus. S. Chand & Co., New Delhi.

Course outcome: Vector calculus

By the end of a course a student will:

CO1: be able to define the scalar and vector product of three and four vectors.

CO2: have knowledge of Gradient, divergence and curl of vectors and their related vector identities.

CO3: be able to describe concept of Orthogonal curvilinear coordinates

CO4: be able to defines line integral, surface integral and volume integral.

Advanced Calculus

Paper code: BM 231 **Time: 3 Hours** **Max. Marks: 27**

Note: The question paper will consist of five sections. Each of the first four sections(I-IV) will contain two questions(each carrying 4.5 marks) and the students shall be asked to attempt one question from each section. Section-V will contain six short answer type questions (each carrying 1.5 marks) without any internal choice covering the entire syllabus and shall be compulsory.

Section – I Continuity, Sequential Continuity, properties of continuous functions, Uniform continuity, chain rule of differentiability. Mean value theorems; Rolle's Theorem and Lagrange's mean value theorem and their geometrical interpretations. Taylor's Theorem with various forms of remainders, Darboux intermediate value theorem for derivatives, Indeterminate forms.

Section – II Limit and continuity of real valued functions of two variables. Partial differentiation. Total Differentials; Composite functions & implicit functions. Change of variables. Homogenous functions & Euler's theorem on homogeneous functions. Taylor's theorem for functions of two variables.

Section – III Differentiability of real valued functions of two variables. Schwarz and Young's theorem. Implicit function theorem. Maxima, Minima and saddle points of two variables. Lagrange's method of multipliers.

Section – IV Curves: Tangents, Principal normals, Binormals, Serret-Frenet formulae. Locus of the centre of curvature, Spherical curvature, Locus of centre of Spherical curvature, Involutes, evolutes, Bertrand Curves. Surfaces: Tangent planes, one parameter family of surfaces, Envelopes.

Books Recommended:

1. C.E. Weatherburn : Differential Geometry of three dimensions, Radhe Publishing House, Calcutta
2. Gabriel Klaumber : Mathematical analysis, Mrcel Dekkar, Inc., New York, 1975
3. R.R. Goldberg : Real Analysis, Oxford & I.B.H. Publishing Co., New Delhi, 1970
4. Gorakh Prasad : Differential Calculus, Pothishala Pvt. Ltd., Allahabad
5. S.C. Malik : Mathematical Analysis, Wiley Eastern Ltd., Allahabad.

6. Shanti Narayan : A Course in Mathemtical Analysis, S.Chand and company, New Delhi
7. Murray, R. Spiegel : Theory and Problems of Advanced Calculus, Schaum Publishing co., New York

Course outcome: Advanced Calculus

By the end of a course a student will be able to:

CO1: Define Continuity, Sequential Continuity, Limit and continuity of real valued functions of two variables and their properties

CO2: Differentiate using chain rule of differentiability.

CO3: Understand Rolle's Theorem, Lagrange's mean value theorem, Taylor's Theorem with various forms of remainders and Darboux intermediate value theorem and their geometrical interpretations.

CO4: Complete understanding of Indeterminate forms, Homogenous functions & Euler's theorem on homogeneous functions

CO5: Define Composite functions & implicit functions.

CO6: Define Involutes, evolutes, Bertrand Curves

Partial Differential Equations

Paper: BM 232 **Time:3 Hours** **Max. Marks: 27**

Note: The question paper will consist of five sections. Each of the first four sections(I-IV) will contain two questions(each carrying 4.5 marks) and the students shall be asked to attempt one question from each section. Section-V will contain six short answer type questions(each carrying 1.5 marks) without any internal choice covering the entire syllabus and shall be compulsory.

Section – I Partial differential equations: Formation, order and degree, Linear and Non-Linear Partial differential equations of the first order: Complete solution, singular solution, General solution, Solution of Lagrange's linear equations, Charpit's general method of solution. Compatible systems of first order equations, Jacobi's method.

Section – II Linear partial differential equations of second and higher orders, Linear and non-linear homogeneous and non-homogeneous equations with constant co-efficients, Partial differential equation with variable co-efficients reducible to equations with constant coefficients, their complimentary functions and particular Integrals, Equations reducible to linear equations with constant co-efficients.

Section – III Classification of linear partial differential equations of second order, Hyperbolic, parabolic and elliptic types, Reduction of second order linear partial differential equations to Canonical (Normal) forms and their solutions, Solution of linear hyperbolic equations, Monge's method for partial differential equations of second order.

Section – IV Cauchy's problem for second order partial differential equations, Characteristic equations and characteristic curves of second order partial differential equation, Method of separation of variables: Solution of Laplace's equation, Wave equation (one and two dimensions), Diffusion (Heat) equation (one and two dimension) in Cartesian Co-ordinate system.

Books Recommended:

1. D.A.Murray: Introductory Course on Differential Equations, Orient Longman, (India), 1967
2. Erwin Kreyszing : Advanced Engineering Mathematics, John Wiley & Sons, Inc., New York, 1999
3. A.R. Forsyth : A Treatise on Differential Equations, Macmillan and Co. Ltd.
4. Ian N.Sneddon : Elements of Partial Differential Equations, McGraw Hill Book Company, 1988
5. Frank Ayres : Theory and Problems of Differential Equations, McGraw Hill Book Company, 1972
6. J.N. Sharma & Kehar Singh : Partial Differential Equations.

Course outcome: Partial Differential Equations

By the end of a course a student will be able to:

CO1: Form Partial differential equations of different orders

CO2: Find complete solution, singular solution and General solution using Charpit's general method, Jacobi's method.

CO3: Solve Linear partial differential equations of second order with constant and variable coefficients.

CO4: Classify linear partial differential equations of second order and Reduce second order linear partial differential equations to Canonical (Normal) forms.

CO5: Solve Laplace's equation, Wave equation (one and two dimensions), Diffusion (Heat) equation (one and two dimension) in Cartesian Co-ordinate system.

Statics

Paper: BM 233 **Max. Marks: 26**

Note: The question paper will consist of five sections. Each of the first four sections(I-IV) will contain two questions (each carrying 5 marks)and the students shall be asked to attempt one question from each section. Section-V will contain six short answer type questions (each carrying 1 marks) without any internal choice covering the entire syllabus and shall be compulsory.

Section – I Composition and resolution of forces. Parallel forces. Moments and Couples.

Section – II Analytical conditions of equilibrium of coplanar forces. Friction. Centre of Gravity.

Section – III Virtual work. Forces in three dimensions. Poinsots central axis.

Section – IV Wrenches. Null lines and planes. Stable and unstable equilibrium.

Books Recommended:

1. S.L. Loney : Statics, Macmillan Company, London
2. R.S. Verma : A Text Book on Statics, Pothishala Pvt. Ltd., Allahabad

Course Outcome: - Statics.

By the end of a course a student will:

CO1 : have knowledge about the nature of forces.
CO2 : Be aware of friction and its various forms and centre of gravity.
CO3 : Be familiar with virtual work.
CO4 : have knowledge regarding wrenches and null lines and planes.

Sequences and Series

Paper: BM 241 **Time: 3 Hours** **Max. Marks: 27**

Note: The question paper will consist of five sections. Each of the first four sections(I-IV) will contain two questions(each carrying 4.5 marks) and the students shall be asked to attempt one question from each section. Section-V will contain six short answer type questions(each carrying 1.5 marks) without any internal choice covering the entire syllabus and shall be compulsory.

Section – I Boundedness of the set of real numbers; least upper bound, greatest lower bound of a set, neighborhoods, interior points, isolated points, limit points, open sets, closed set, interior of a set, closure of a set in real numbers and their properties. Bolzano-Weiestrass theorem, Open covers, Compact sets and Heine-Borel Theorem.

Section – II Sequence: Real Sequences and their convergence, Theorem on limits of sequence, Bounded and monotonic sequences, Cauchy's sequence, Cauchy general principle of convergence, Subsequences, Subsequential limits. Infinite series: Convergence and divergence of Infinite Series, Comparison Tests of positive terms Infinite series, Cauchy's general principle of Convergence of series, Convergence and divergence of geometric series, Hyper Harmonic series or p-series.

Section – III Infinite series: D-Alembert's ratio test, Raabe's test, Logarithmic test, de Morgan and Bertrand's test, Cauchy's Nth root test, Gauss Test, Cauchy's integral test, Cauchy's condensation test.

Section – IV Alternating series, Leibnitz's test, absolute and conditional convergence, Arbitrary series: abel's lemma, Abel's test, Dirichlet's test, Insertion and removal of parenthesis, re-arrangement of terms in a series, Dirichlet's theorem, Riemann's Re-arrangement theorem, Pringsheim's theorem (statement only), Multiplication of series, Cauchy product of series, (definitions and examples only) Convergence and absolute convergence of infinite products.

Books Recommended:

1. R.R. Goldberg : Real Analysis, Oxford & I.B.H. Publishing Co., New Delhi, 1970
2. S.C. Malik : Mathematical Analysis, Wiley Eastern Ltd., Allahabad.
3. Shanti Narayan : A Course in Mathematical Analysis, S.Chand and company, New Delhi
4. Murray, R. Spiegel : Theory and Problems of Advanced Calculus, Schaum Publishing co., New York
5. T.M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985
6. Earl D. Rainville, Infinite Series, The Macmillan Co., New York.

Course Outcome: - Sequence and series

By the end of a course a student will:

CO1: Have knowledge of Bolzano-Weiestrass theorem and Heine-Borel Theorem.

CO2: Be able to define concepts namely Boundedness, neighborhoods, interior points, isolated points, limit points, open and closed set, closure of a set in real numbers, Open covers and Compact sets.

CO3: Have knowledge of some simple techniques for testing the convergence of sequences and series

CO4: Have a detailed understanding of how Cauchy's criterion for the convergence of real sequences and series follows from the completeness axiom for R.

CO5: Be able to distinguish between the concepts of sequence and series, and determine limits of sequences and convergence and approximate sums of series.

Special Functions and integral Transforms

Paper code: BM 242 Time: 3 Hours Max. Marks: 27

Note: The question paper will consist of five sections. Each of the first four sections(I-IV) will contain two questions(each carrying 4.5 marks) and the students shall be asked to attempt one question from each section. Section-V will contain six short answer type questions(each carrying 1.5 marks) without any internal choice covering the entire syllabus and shall be compulsory.

Section – I Series solution of differential equations – Power series method, Definitions of Beta and Gamma functions. Bessel equation and its solution: Bessel functions and their properties-Convergence, recurrence, Relations and generating functions, Orthogonality of Bessel functions.

Section – II Legendre and Hermite differentials equations and their solutions: Legendre and Hermite functions and their properties-Recurrence Relations and generating functions. Orhogonality of Legendre and Hermite polynomials. Rodrigues' Formula for Legendre & Hermite Polynomials, Laplace Integral Representation of Legendre polynomial.

Section – III Laplace Transforms – Existence theorem for Laplace transforms, Linearity of the Laplace transforms, Shifting theorems, Laplace transforms of derivatives and integrals, Differentiation and integration of Laplace transforms, Convolution theorem, Inverse Laplace transforms, convolution theorem, Inverse Laplace transforms of derivatives and integrals, solution of ordinary differential equations using Laplace transform.

Section – IV Fourier transforms: Linearity property, Shifting, Modulation, Convolution Theorem, Fourier Transform of Derivatives, Relations between Fourier transform and Laplace transform, Parseval's identity for Fourier transforms, solution of differential Equations using Fourier Transforms.

Books Recommended:

1. Erwin Kreyszing : Advanced Engineering Mathematics, John Wiley & Sons, Inc., New York, 1999
2. A.R. Forsyth : A Treatise on Differential Equations, Macmillan and Co. Ltd.
3. I.N. Sneddon : Special Functions on mathematics, Physics & Chemistry.
4. W.W. Bell : Special Functions for Scientists & Engineers.

5. I.N. Sneddon: the use of integral transform, McGraw Hill, 1972 6. Murray R. Spiegel: Laplace transform, Schaum’s Series.

Course outcome:

By the end of a course a student will:

CO1: Be able to define Beta and Gamma functions and related problems.

CO2: Have deep knowledge of Bessel functions and their properties.

CO3: Be able to solve Legendre and Hermite differentials equations and develop understanding about its properties.

CO4: Able to solve Laplace Transforms and inverse Laplace transforms of derivatives and integrals and ordinary differential equations using Laplace transform.

CO5: Able to solve Fourier transforms and differential Equations using Fourier Transforms.

Programming in C and Numerical Methods

Part-A (Theory) Paper: BM 243 Time:3Hours Max. Marks: 20

Note: The question paper will consist of five sections. Each of the first four sections (I-IV) will contain two questions, each carrying 3.5 marks and the students shall be asked to attempt one question from each section. Section-V will contain six short answer type questions each carrying 1 marks without any internal choice covering the entire syllabus and shall be compulsory.

Section – I Programmer's model of a computer, Algorithms, Flow charts, Data types, Operators and expressions, Input / outputs functions.

Section – II Decisions control structure: Decision statements, Logical and conditional statements, Implementation of Loops, Switch Statement & Case control structures. Functions, Preprocessors and Arrays.

Section – III Strings: Character Data Type, Standard String handling Functions, Arithmetic Operations on Characters. Structures: Definition, using Structures, use of Structures in Arrays and Arrays in Structures. Pointers: Pointers Data type, Pointers and Arrays, Pointers and Functions. Solution of Algebraic and Transcendental equations: Bisection method, Regula-Falsi method, Secant method, Newton-Raphson's method. Newton's iterative method for finding pth root of a number, Order of convergence of above methods.

Section – IV Simultaneous linear algebraic equations: Gauss-elimination method, Gauss-Jordan method, Triangularization method (LU decomposition method). Crout's method, Cholesky Decomposition method. Iterative method, Jacobi's method, Gauss-Seidal's method, Relaxation method.

Books Recommended:

1. B.W. Kernighan and D.M. Ritchie : The C Programming Language, 2nd Edition
2. V. Rajaraman : Programming in C, Prentice Hall of India, 1994
3. Byron S. Gottfried : Theory and Problems of Programming with C, Tata McGraw-Hill Publishing Co. Ltd., 1998 17

4. M.K. Jain, S.R.K.Lyengar, R.K. Jain : Numerical Method, Problems and Solutions, New Age International (P) Ltd., 1996
5. M.K. Jain, S.R.K. Lyengar, R.K. Jain : Numerical Method for Scientific and Engineering Computation, New Age International (P) Ltd., 1999
6. Computer Oriented Numerical Methods, Prentice Hall of India Pvt. Ltd.
7. Programming in ANSI C, E. Balagurusamy, Tata McGraw-Hill Publishing Co. Ltd.
8. Programming in ANSI C, E. Balagurusamy, Tata McGraw-Hill Publishing Co. Ltd.
9. Babu Ram: Numerical Methods, Pearson Publication.
10. R.S. Gupta, Elements of Numerical Analysis, Macmillan's India 2010.

Course Outcome: Programming in C and Numerical Methods

By the end of a course a student will:

CO1: have knowledge of Programmer's model of a computer, Algorithms, Flow charts, Data types, Operators and expressions, Input / outputs functions.

CO2:have knowledge of the concept of Decisions control structure: Decision statements, Logical and conditional statements, Implementation of Loops, Switch Statement & Case control structures. Functions, Preprocessors and Arrays.

CO3: have knowledge of the concepts of string and pointer. Learn the Solution of Algebraic and Transcendental equations.

CO4: be able to estimates the numerical solutions of Simultaneous linear algebraic equations.

Real Analysis

Paper: BM 351 **Time:3 Hours** **Max. Marks: 27**

Note: The question paper will consist of five sections. Each of the first four sections(I-IV) will contain two questions(each carrying 4.5 marks) and the students shall be asked to attempt one question from each section. Section-V will contain six short answer type questions(each carrying 1.5 marks) without any internal choice covering the entire syllabus and shall be compulsory.

Section- I Riemann integral, Integrabililty of continuous and monotonic functions, The Fundamental theorem of integral calculus. Mean value theorems of integral calculus.

Section – II Improper integrals and their convergence, Comparison tests, Abel's and Dirichlet's tests, Frullani's integral, Integral as a function of a parameter. Continuity, Differentiability and integrability of an integral of a function of a parameter.

Section - III Definition and examples of metric spaces, neighborhoods, limit points, interior points, open and closed sets, closure and interior, boundary points, subspace of a metric space, equivalent metrics, Cauchy sequences, completeness, Cantor's intersection theorem, Baire's category theorem, contraction Principle.

Section – IV Continuous functions, uniform continuity, compactness for metric spaces, sequential compactness, Bolzano-Weierstrass property, total boundedness, finite intersection property, continuity in relation with compactness, connectedness , components, continuity in relation with connectedness.

Books Recommended:

1. P.K. Jain and Khalil Ahmad: Metric Spaces, 2nd Ed., Narosa, 2004
2. T.M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985
3. R.R. Goldberg : Real analysis, Oxford & IBH publishing Co., New Delhi, 1970

4. D. Somasundaram and B. Choudhary : A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1997
5. Shanti Narayan : A Course of Mathematical Analysis, S. Chand & Co., New Delhi
6. E.T. Copson, Metric Spaces, Cambridge University Press, 1968.
7. G.F. Simmons : Introduction to Topology and Modern Analysis, McGraw Hill, 1963.

Course Outcome : Real Analysis

By the end of a course a student will be able to:

CO1: describe the properties of Riemann integral.

CO2: Examine the convergence of improper integral and Integral as a function of a parameter

CO3: Extend the idea of metric space, interior, exterior, boundary, Limit points, open and closed sets, Investigates the properties of Cauchy sequences, completeness, Cantor's intersection theorem, Baire's category theorem, contraction Principle

CO4:Investigate the ideas of continuity, uniform continuity, compact sets connectedness , components, continuity in relation with connectedness.

Groups and Rings

Paper: BM 352 **Time: 3 Hours** **Max. Marks: 27**

Note: The question paper will consist of five sections. Each of the first four sections(I-IV) will contain two questions(each carrying 4.5 marks) and the students shall be asked to attempt one question from each section. Section-V will contain six short answer type questions (each carrying 1.5 marks) without any internal choice covering the entire syllabus and shall be compulsory

Section – I Definition of a group with example and simple properties of groups, Subgroups and Subgroup criteria, Generation of groups, cyclic groups, Cosets, Left and right cosets, Index of a sub-group Coset decomposition, Largrage's theorem and its consequences, Normal subgroups, Quotient groups,

Section – II Homoomorphisms, isomophisms, automorphisms and inner automorphisms of a group. Automorphisms of cyclic groups, Permutations groups. Even and odd permutations. Alternating groups, Cayley's theorem, Center of a group and derived group of a group.

Section – III Introduction to rings, subrings, integral domains and fields, Characteristics of a ring. Ring homomorphisms, ideals (principle, prime and Maximal) and Quotient rings, Field of quotients of an integral domain.

Section – IV Euclidean rings, Polynomial rings, Polynomials over the rational field, The Eisenstein's criterion, Polynomial rings over commutative rings, Unique factorization domain, R unique factorization domain implies so is R[X1 , X2……Xn]

Books Recommended:

1. I.N. Herstein : Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpal : Basic Abstract Algebra (2nd edition).
3. Vivek Sahai and Vikas Bist : Algebra, NKarosa Publishing House.
4. I.S. Luther and I.B.S. Passi : Algebra, Vol.-II, Norsa Publishing House.
5. J.B. Gallian: Abstract Algebra, Narosa Publishing House.

Course Outcome : Groups and Rings

By the end of a course a student will be able to:

CO1: Assess properties implied by the definitions of groups and rings,

CO2: Use various canonical types of groups (including cyclic groups and groups of permutations) and canonical types of rings (including polynomial rings),

CO3: Analyze and demonstrate examples of subgroups, normal subgroups and quotient groups.

CO4: Analyze and demonstrate examples of ideals and quotient rings,

CO5: Use the concepts of isomorphism and homomorphism for groups and rings, and

CO6: Produce rigorous proofs of propositions arising in the context of groups and rings.

Numerical Analysis

Paper: BM 353 **Time: 3 Hours** **Max. Marks: 20**

Note:- The question paper will consist of five sections. Each of the first four sections (I-IV) will contain two questions, each carrying 3.5 marks and the students shall be asked to attempt one question from each section. Section-V will contain six short answer type questions each carrying 1 marks without any internal choice covering the entire syllabus and shall be compulsory.

Section – I Finite Differences operators and their relations. Finding the missing terms and effect of error in a difference tabular values, Interpolation with equal intervals: Newton's forward and Newton's backward interpolation formulae. Interpolation with unequal intervals: Newton's divided difference, Lagrange's Interpolation formulae, Hermite Formula.

Section – II Central Differences: Gauss forward and Gauss's backward interpolation formulae, Sterling, Bessel Formula. Probability distribution of random variables, Binomial distribution, Poisson's distribution, Normal distribution: Mean, Variance and Fitting.

Section – III Numerical Differentiation: Derivative of a function using interpolation formulae as studied in Sections –I & II. Eigen Value Problems: Power method, Jacobi's method, Given's method, House-Holder's method, QR method, Lanczos method.

Section – IV Numerical Integration: Newton-Cote's Quadrature formula, Trapezoidal rule, Simpson's onethird and three-eighth rule, Chebychev formula, Gauss Quadrature formula. Numerical solution of ordinary differential equations: Single step methods-Picard's method. Taylor's series method, Euler's method, Runge-Kutta Methods. Multiple step methods; Predictor-corrector method, Modified Euler's method, Milne-Simpson's method.

Books Recommended:

1. Babu Ram: Numerical Methods, Pearson Publication.
2. R.S. Gupta, Elements of Numerical Analysis, Macmillan's India 2010.
3. M.K. Jain, S.R.K.Iyengar, R.K. Jain : Numerical Method, Problems and Solutions, New Age International (P) Ltd., 1996
4. M.K. Jain, S.R.K. Iyengar, R.K. Jain : Numerical Method for Scientific and Engineering Computation, New Age International (P) Ltd., 1999

5. C.E. Froberg : Introduction to Numerical Analysis (2nd Edition).
6. Melvin J. Maaron : Numerical Analysis-A Practical Approach, Macmillan Publishing Co., Inc., New York
7. R.Y. Rubnistein : Simulation and the Monte Carlo Methods, John Wiley, 1981
8. Radhey S. Gupta: Elements of Numerical Analysis, Macmillan Publishing Co.

Course Outcome : Numerical Analysis

By the end of a course a student will:

CO1: Be able to derive numerical methods for approximating the solution of problems using Central Differences formulas,
CO2: Be able to analyze the error incumbent in any such numerical approximation,
CO3: Have deep understanding of Probability distribution of random variables,
CO4: Be able to implement a variety of numerical algorithms using appropriate technology
CO5: Be able to compare the viability of different approaches to the numerical solution of problems arising in roots of solution of equations, interpolation and approximation, numerical differentiation and integration, solution of linear systems.

Real and Complex Analysis

Paper: BM 361 **Time: 3Hours** **Max. Marks: 27**

Note: The question paper will consist of five sections. Each of the first four sections (I-IV) will contain two questions (each carrying 4.5 marks) and the students shall be asked to attempt one question from each section. Section-V will contain six short answer type questions (each carrying 1.5 marks) without any internal choice covering the entire syllabus and shall be compulsory.

Section – I Jacobians, Beta and Gama functions, Double and Triple integrals, Dirichlets integrals, change of order of integration in double integrals.

Section – II Fourier's series: Fourier expansion of piecewise monotonic functions, Properties of Fourier Coefficients, Dirichlet's conditions, Parseval's identity for Fourier series, Fourier series for even and odd functions, Half range series, Change of Intervals.

Section – III Extended Complex Plane, Stereographic projection of complex numbers, continuity and differentiability of complex functions, Analytic functions, Cauchy-Riemann equations. Harmonic functions.

Section – IV Mappings by elementary functions: Translation, rotation, Magnification and Inversion. Conformal Mappings, Mobius transformations. Fixed pints, Cross ratio, Inverse Points and critical mappings.

Books Recommended:

1. T.M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985
2. R.R. Goldberg : Real analysis, Oxford & IBH publishing Co., New Delhi, 1970
3. D. Somasundaram and B. Choudhary : A First Course in Mathematical, Analysis, Narosa Publishing House, New Delhi, 1997
4. Shanti Narayan : A Course of Mathematical Analysis, S. Chand & Co., New Delhi
5. R.V. Churchill & J.W. Brown: Complex Variables and Applications, 5th Edition, McGraw-Hill, New York, 1990
6. Shanti Narayan : Theory of Functions of a Complex Variable, S. Chand & Co., New Delhi.

Course Outcome : Real and Complex Analysis

By the end of a course a student will:

CO1: Be able to solve problems related to Jacobians, Beta and Gama functions.

CO2: Be able to solve integrals considering double and triple integrals.

CO3: Have complete knowledge of Fourier's series.

CO4: Introduce elementary complex functions

CO5: Define and analyze limits and continuity for complex functions as well as consequences of continuity

CO6: Determine whether a given function is differentiable, and if so find its derivative and Use differentiation rules to compute derivatives

CO7: Understand the significance of differentiability for complex functions and be familiar with the Cauchy-Riemann equations

CO8: Conceive the concepts of analytic functions and will be familiar with the elementary complex functions and their properties

CO9: Apply the concept and consequences of analyticity and the Cauchy-Riemann equations and of results on harmonic functions.

CO10: Understand the significance of Stereographic projection of complex numbers

CO11: Will have deep knowledge of Mappings by elementary functions: Translation, rotation, Magnification and Inversion including Conformal Mappings, Mobius transformations

Linear Algebra

Paper: BM 362 **Time: 3Hours** **Max. Marks: 27**

Note: The question paper will consist of five sections. Each of the first four sections(I-IV) will contain two questions(each carrying 4.5 marks) and the students shall be asked to attempt one question from each section. Section-V will contain six short answer type questions(each carrying 1.5 marks) without any internal choice covering the entire syllabus and shall be compulsory.

Section – I Vector spaces, subspaces, Sum and Direct sum of subspaces, Linear span, Linearly Independent and dependent subsets of a vector space. Finitely generated vector space, Existence theorem for basis of a finitely generated vactor space, Finite dimensional vector spaces, Invariance of the number of elements of bases sets, Dimensions, Quotient space and its dimension.

Section–II Homomorphism and isomorphism of vector spaces, Linear transformations and linear forms on vactor spaces, Vactor space of all the linear transformations Dual Spaces, Bidual spaces, annihilator of subspaces of finite dimentional vactor spaces, Null Space, Range space of a linear transformation, Rank and Nullity Theorem,

Section – III Algebra of Linear Transformation, Minimal Polynomial of a linear transformation, Singular and non-singular linear transformations, Matrix of a linear Transformation, Change of basis, Eigen values and Eigen vectors of linear transformations.

Section – IV Inner product spaces, Cauchy-Schwarz inequality, Orthogonal vectors, Orthogonal complements, Orthogonal sets and Basis, Bessel's inequality for finite dimensional vector spaces, GramSchmidt, Orthogonalization process, Adjoint of a linear transformation and its properties, Unitary linear transformations.

Books Recommended:

1. I.N. Herstein : Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpal : Basic Abstract Algebra (2nd edition).
3. Vivek Sahai and Vikas Bist : Algebra, Narosa Publishing House.
4. I.S. Luther and I.B.S. Passi : Algebra, Vol.-II, Narosa Publishing House.

Course outcome: Linear Algebra

By the end of a course a student will:

CO1: have deep knowledge of vector space, subspace, quotient spaces, basis and dimension of vector spaces.

CO2: be able to extend Various theorems based on Homomorphism and isomorphism of vector spaces.

CO3: be able to describe relation between nullity and rank.

CO3: have clear idea regarding Matrix of a linear Transformation, Change of basis, Eigen values and Eigen vectors of linear transformations.

CO4: be able to define an idea about inner product space and their properties.

Dynamics

Paper: BM 363 **Time: 3 Hours** **Max. Marks: 27**

Note: The question paper will consist of five sections. Each of the first four sections(I-IV) will contain two questions (each carrying 5 marks) and the students shall be asked to attempt one question from each section. Section-V will contain six short answer type questions (each carrying 1 marks) without any internal choice covering the entire syllabus and shall be compulsory.

Section – I Velocity and acceleration along radial, transverse, tangential and normal directions. Relative velocity and acceleration. Simple harmonic motion. Elastic strings.

Section – II Mass, Momentum and Force. Newton's laws of motion. Work, Power and Energy. Definitions of Conservative forces and Impulsive forces.

Section – III Motion on smooth and rough plane curves. Projectile motion of a particle in a plane. Vector angular velocity.

Section – IV General motion of a rigid body. Central Orbits, Kepler laws of motion. Motion of a particle in three dimensions. Acceleration in terms of different co-ordinate systems.

Books Recommended:

1. S.L.Loney : An Elementary Treatise on the Dynamics of a Particle and a Rigid Bodies, Cambridge University Press, 1956
2. F. Chorlton : Dynamics, CBS Publishers, New Delhi
3. A.S. Ramsey: Dynamics Part-1&2, CBS Publisher & Distributors.

Course Outcome : Dynamics

By the end of a course a student will:

CO1: Have deep knowledge of Velocity and acceleration along radial, transverse, tangential and normal directions also Acceleration in terms of different co-ordinate systems.

CO2: Be able to define Relative velocity and acceleration.

CO3: Be able to solve problems related to Simple harmonic motion and Elastic strings.

CO4: Be able to define terms like Mass, Momentum, Force (including Conservative forces and Impulsive forces) , Work, Power and Energy.

CO5: Have complete knowledge of Motion on smooth and rough plane curves and Projectile motion of a particle in a plane.

CO6: Be able to solve problems related to Central Orbits, Kepler laws of motion.