छत्रपति शाहू जी महाराज विश्वविद्यालय, कानपुर

CHHATRAPATI SHAHU JI MAHRAJ UNIVERSITY, KANPUR

(पूर्ववर्ती कानपुर विश्वविद्यालय कानपुर)

Formerly Kanpur University, Kanpur – 208024

A Documentary Support

For

Metric No. – 1.1.1

Programme Outcomes & Course Outcomes

Under the

Criteria - I

(Curriculum Design and Development)

Key Indicator - 1.1

In

Metric No. – 1.1.1

B.Sc. (Hons.) Mathematics

Co-ordinator
Internal Quality Assurance Cell
CSJM University, Kanpur

(Registrar)
C.S.J.M.University
Kanpur

REGISTRAR
C.S.J.M. UNIVERSITY
KANPUR

DEPARTMENT OF MATHEMATICS,

SCHOOL OF BASIC SCIENCES, UIET, CSJM UNIVERSITY

KANPUR

Vision

- To develop logical, analytical and Mathematical thinking power in the minds of students in order to cater the Mathematical needs of the society.

Mission

- To offer globally-relevant, industry-linked, research-focused, technology-enabled seamless education at the graduate, postgraduate and research levels in various areas of Mathematical sciences keeping in mind that the manpower so spawned is excellent in quality, is relevant to the global scientific and technological needs, is motivated to give its best and is committed to the growth of the Nation.

B.Sc. (Hons) in Mathematics (3 year duration)
Department of Mathematics, School of sciences
CSJM University, Kanpur

Program Outcomes of B.Sc. (Hons) in Mathematics, School of Basic Sciences:

1. Bachelor's degree in mathematics is the culmination of in-depth knowledge of algebra, calculus, geometry, differential equations and several other branches of mathematics.
2. This also leads to study of related areas like computer science, Financial Mathematics, statistics and many more.

3. This programme helps learners in building a solid foundation for higher studies in mathematics.

4. The skills and knowledge gained has intrinsic beauty, which also leads to proficiency in analytical reasoning.

5. This can be utilized in modelling and solving real life problems. Students undergoing this programme learn to logically question assertions, to recognize patterns and to distinguish between essential and irrelevant aspects of problems.

6. They also share ideas and insights while seeking and benefitting from knowledge and insight of others.

7. This helps them to learn behave responsibly in a rapidly changing interdependent society. Students completing this programme will be able to present mathematics clearly and precisely, make vague ideas precise by formulating them in the language of mathematics.

8. Describe mathematical ideas from multiple perspectives and explain fundamental concepts of mathematics to non-mathematicians.

9. Completion of this programme will also enable the learners to join teaching profession in primary and secondary schools.

10. This programme will also help students to enhance their employability for government jobs, jobs in banking, insurance and investment sectors, data analyst jobs and jobs in various other public and private enterprises and provide an opprtunity to choose carrer at global, national, regional, local level in the field of mathematics.

Program Specific Outcomes (PSOs):

1. Think in a critical manner.

2. Familiarize the students with suitable tools of mathematical analysis to handle issues and Problems in mathematics and related sciences.
3. Acquire good knowledge and understanding to solve specific theoretical and applied problems in advanced areas of mathematics and statistics.

4. Provide students/learners sufficient knowledge and skills enabling them to undertake further studies in mathematics and its allied areas on multiple disciplines concerned with mathematics.

5. Encourage the students to develop a range of generic skills helpful in employment, internships and social activity.

Program Educational Outcomes (PEOs):

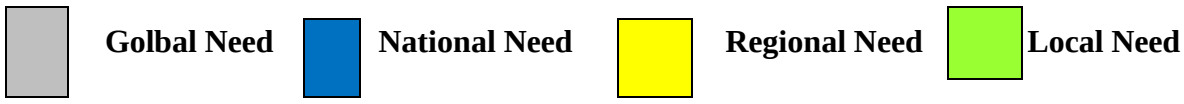
1. The Bachelor's Degree in B.Sc. (Hons) Mathematics is awarded to the students on the basis of knowledge, understanding, skills, attitudes, values and academic achievements sought to be acquired by learners at the end of this program.

2. The learning outcomes of mathematics for this course are aimed at facilitating the learners to acquire these attributes, keeping in view of their preferences and aspirations for knowledge of mathematics. Mathematics is the study of quantity, structure, space and change.

3. It has very broad scope in science, engineering and social sciences. The key areas of study in mathematics are Calculus, Algebra, Geometry, Analysis, Differential Equations and Mechanics.

4. The graduates will be well prepared for successful careers at Local, National and International level, and can work as analyst, quality controller, research assistant at various organizations.

5. The graduates will engage in professional activities to enhance their own stature and simultaneously contribute to the profession and the society at large.



Semester-wise Course Structure (B. Sc. (Hons) Mathematics)

1st Year–Semester I

Sl. No.	Course Code	Course Title	L	T	P	Credits	Internal Marks	External Marks	Total Marks
1.	BMC-101	Calculus	6	0	0	6	25	75	100
2.	BMC-102	Algebra	6	0	0	6	25	75	100
3.	GM-101	Differential & Integral Calculus	6	0	0	6	25	75	100
4.	AECC1	English Communication	2	0	0	2	25	75	100
		Total	**20**	**0**	**0**	**20**	**100**	**300**	**400**

1st Year–Semester II

Sl. No.	Course Code	Course Title	L	T	P	Credits	Internal Marks	External Marks	Total Marks
1.	BMC-201	Multivariable Calculus	6	0	0	6	25	75	100
2.	BMC-202	Ordinary Differential Equations	6	0	0	6	25	75	100
3.	GM-102	Linear Algebra & Differential Equations	6	0	0	6	25	75	100
4.	AECC2	Environmental Science	2	0	0	2	25	75	100
		Total	**20**	**0**	**0**	**20**	**100**	**300**	**400**

2nd Year–SemesterIII

Sl. No.	Course Code	Course Title	L	T	P	Credits	Internal Marks	External Marks	Total Marks
1.	BMC-301	Real Analysis	6	0	0	6	25	75	100
2.	BMC-302	Group Theory	6	0	0	6	25	75	100
3.	BMC-303	Probability and statistics	6	0	0	6	25	75	100
4.	GM-103	Integral Transform	6	0	0	6	25	75	100
5.	SEC1	Vocational Course	2	0	0	2	40	60	100
		Total	**26**	**0**	**0**	**26**	**140**	**360**	**500**

2nd Year–Semester IV

Sl. No.	Course Code	Course Title	L	T	P	Credits	Internal Marks	External Marks	Total Marks
1.	BMC-401	Mechanics	6	0	0	6	25	75	100
2.	BMC-402	Linear Algebra	6	0	0	6	25	75	100
3.	BMC-403	Partial Differential Equations	6	0	0	6	25	75	100
4.	GM-104	Statistics	6	0	0	6	25	75	100
5.	SEC2	Vocational Course	2	0	0	2	40	60	100
		Total	**26**	**0**	**0**	**26**	**140**	**360**	**500**

3rd Year–Semester V

Sl. No.	Course Code	Course Title	L	T	P	Credits	Internal Marks	External Marks	Total Marks
1.	BMC-501	Set Theory and Metric Spaces	6	0	0	6	25	75	100
2.	BMC-502	Advanced Algebra	6	0	0	6	25	75	100
3.	BMC-503 BMC-504 **(Elective)**	**Any Two** **BMC -503 & 504 (I)-(vi)** BMC-(i):Mathematical Logic BMC-(ii):Integral Transforms and Fourier Analysis BMC(iii):Linear Programming BMC -(iv): Information Theory and Coding BMC -(v): Graph Theory BMC(vi):Special Theory and Relativity	6+6	0	0	6+6	25+25	75+75	100+100
		Total	**24**	**0**	**0**	**24**	**100**	**300**	**400**

3rdYear–Semester VI

Sl. No.	CourseCode	CourseTitle	L	T	P	Credits	Internal Marks	External Marks	Total Marks
1.	BMC-601	Complex Analysis	6	0	0	6	25	75	100
2.	BMC-602	Numerical Analysis	6	0	0	6	25	75	100
3.	BMC-603 And BMC-604 (Elective)	**(Any Two) BMC-603 & 604 (i)-(viii)** BMC -(i): Discrete Mathematics BMC -(ii): Number Theory BMC -(iii): Mathematical Finance BMC -(iv) : C++ Programming for Mathematics BMC -(v) :Cryptography	6+6	0	0	6+6	25+25	75+75	100+100
		Total	**24**	**0**	**0**	**24**	**100**	**300**	**400**

Total Credits–140.

Detailed Syllabus

Semester I

CourseCode: BMC-101 Toatl Marks: 100, Credit: 6
CourseName: Calculus

Course out comes(CO): At the end of the course, the student will be able to:

CO1	Student would learn about Real number systems as well as convergence of sequence.
CO2	It provides the basic concept of limit and continuity with geometrical interpretation.
CO3	It provides the differentiability of real valued functions with geometrical interpretation.

CO4	Determine the Taylor's and Maclaurin's series expansion of real valued function and find its Maxima and Minima
CO5	Student would learn about Curve Tracing

Course Details:

Unit-I: Real number system: Completeness axiom, density of rationals (irrationals) in reals, convergence of a sequence, Sandwich theorem, Monotone sequences, Cauchy Criterion, Subsequence, Bolzano-Weierstrass theorem.

Unit-II: Limit and Continuity ε-δ definition of limit of a real valued function, Limit at infinity and infinite limits; Continuity of a real valued function, Properties of continuous functions, Intermediate value theorem, Geometrical interpretation of continuity, Types of discontinuity; Uniform continuity.

Unit-III: Differentiability, Differentiability of a real valued function, Geometrical interpretation of differentiability, Relation between differentiability and continuity, Differentiability and monotonicity, Chain rule of differentiation; Successive differentiation, Leibnitz's theorem.

Unit-IV: Expansions of Functions Maclaurin's and Taylor's theorems for expansion of a function in an infinite series, Taylor's theorem in finite form with Lagrange, Cauchy and Roche– Schlomilch forms of remainder; Maxima and minima.

Unit-V: Curvature, Asymptotes and Curve Tracing Curvature; Asymptotes of general algebraic curves, Parallel asymptotes, Asymptotes parallel to axes; Symmetry, Concavity and convexity, Points of inflection.

Text and Reference Books:

1. Howard Anton, I. Bivens& Stephan Davis (2016), Calculus (10th edition), Wiley India.

2. Gabriel Klambauer (1986), Aspects of Calculus, Springer-Verlag.

3. Wieslaw Krawcewicz & Bindhyachal Rai (2003), Calculus with Maple Labs, Narosa.

4. Gorakh Prasad (2016), Differential Calculus (19th edition), Pothishala Pvt. Ltd.

5. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018), Thomas Calculus (14th edition), Pearson Education.

Semester I

CourseCode: BMC-102 Toatl Marks: 100, Credit: 6
CourseName: Algebra

Course out comes(CO): At the end of the course, the student will be able to:

CO1	Determine the roots of equation by different methods. .
CO2	The course comprises of the study of relations and functions, countable and uncountable sets, divisibility, congruences and mathematical induction.
CO3	Determine the solution of the system of linear equations by rank of matrix. .
CO4	Find the inverse of matrix, Eigenvalue and eigenvectors.
CO5	Learn about and work with vector spaces and subspaces.

Course Details:

Unit-I: Theory of Equations and Complex Numbers Elementary theorems on the roots of an equations including Cardan's method, The remainder and factor theorems, Synthetic division, Factored form of a polynomial, The Fundamental theorem of algebra, Relations between the roots and the coefficients of polynomial equations, Imaginary roots, Integral and rational roots; Polar representation of complex numbers, The nth roots of unity, De Moivre's theorem for integer and rational indices and its applications.

Unit-II: Relations and Basic Number Theory Relations, Equivalence relations, Equivalence classes; Functions, Composition of functions, Inverse of a function; Finite, countable and uncountable sets; The division algorithm, Divisibility and the Euclidean algorithm, The fundamental theorem of arithmetic, Modular arithmetic and basic properties of congruences; Principles of mathematical induction and well ordering.

Unit-III: Row Echelon Form of Matrices and Applications Systems of linear equations, Row reduction and echelon forms, Linear independence, The rank of a matrix and applications.

Unit-IV: Introduction to linear transformations, The matrix of a linear transformation, Matrix operations, Determinants, The inverse of a matrix, Characterizations of invertible matrices; Applications to Computer Graphics; Eigenvalues and eigenvectors, The characteristic equation and the Cayley–Hamilton theorem.

Text and Reference Books:

1. TituAndreescu,&DorinAndrica (2014). Complex Numbers from A to...Z. (2nd edition). Birkhäuser.
2. Robert J. T. Bell (1994). An Elementary Treatise on Coordinate Geometry of Three Dimensions. Macmillan India Ltd.
3. D. Chatterjee (2009). Analytical Geometry: Two and Three Dimensions. Narosa Publishing House.

Semester I

CourseCode:GM-101 Total Marks: 100, Credit:6
CourseName: Differential & Integral Calculus

Course out comes (CO): At the end of the course,the student will be able to:

CO1	Explain the relationship between the derivative of a function as a function and the notion of the derivative as the slope of the tangent line to a function at a point.
CO2	Compare and contrast the ideas of continuity and differentiability.
CO3	To find maxima and minima, critical points and inflection points of functions and to determine the concarity of curves
CO4	Double integral and application
CO5	Triple integral and their applications

Course Details:

Unit I: Differential Calculus: Differentiability and differentials. Successive differentiation and Leibnitz Theorem. Statement of Rolle's Theorem. Mean Value Theorem, Taylor and Maclaurin's Theorems, indeterminate forms. Limits and continuity of functions of two variables.
Unit-II: Partial Differentiation: Definition of Partial derivatives. Euler's Theorem on homogeneous functions, total derivative of composite & implicit functions, Errors and approximations.
Unit-III: Applications: Asymptotes. Curvature, Concavity, Convexity and points of inflection.Extreme Points, Envelopes. Curve tracing, Tracing of Cartesian, Polar Curves,

Unit-IV: Integral Calculus: Integration, Beta and Gamma Functions,Application of Integral Calculus: Quadrature, Area, length of arc, Arc length as a parameter. Multiple Integrals: Definitions, Double integrals, Triple Integral.

Text and Reference Books:

1. Shanti Nayaran, Differential Calculus, ShyamLal Charitable Trust, Delhi, 2002.
2. Shanti Nayaran, Integral Calculus, ShyamLal Charitable Trust, Delhi, 2002.
3. N. Piskunov, Differential Calculus & Integral Calculus, Vol. 1 and II, Mir Pub., 1981.
4. C.B. Thomas, Calculus and Analytical Geometry, Narosa Pub., Delhi, 1996.
5. N. Piskunov, Differential Calculus & Integral Calculus, Vol. 1 and II, Mir Pub., 1981.
6. R.Courant, and JohnF., Introduction to Calculus and Analysis, Volume I, Spring.

Semester II

CourseCode:BMC-201 Total Marks: 100, Credit: 6
CourseName: Multivariable Calculus

Course out comes(CO): At the end of the course,the student will be able to:

CO1	Students able to understand the concept of limit and continuity for the function of several variables.
CO2	It provides the differentiability, Jacobian's, applications of Euler's Theorem, Taylor's and Maclaurin's series expansion for the function of several variables.
CO3	Student would learn about Maxima and Minima, curl, gradient and divergence for the function of several variables.
CO4	Students learn how to evaluate the Multiple integrals.
CO5	It provides the applications of Gauss's, Green's and Stoke's Theorem

Course Details:

Unit-I: Partial Differentiation Functions of several variables, Level curves and surfaces, Limits and continuity, Partial differentiation, Tangent planes, Chain rule, Directional derivatives, The gradient, Maximal and normal properties of the gradient, Tangent planes and normal lines.

Unit-II: Differentiation Higher order partial derivatives, Total differential and differentiability, Jacobians, Change of variables, Euler's theorem for homogeneous functions, Taylor's theorem for functions of two variables and more variables, Envelopes and evolutes.

Unit-III: Extreme of Functions and Vector Field Extrema of functions of two and more variables, Method of Lagrange multipliers, constrained optimization problems, Definition of vector field, Divergence, curl, gradient and vector identities.

Unit-IV: Double and Triple Integrals Double integration over rectangular and nonrectangular regions, Double integrals in polar coordinates, Triple integral over a parallelepiped and solid regions, Volume by triple integrals, Triple integration in cylindrical and spherical coordinates, Change of variables in double and triple integrals, Dirichlet integral.

Unit-V: Green's, Stokes' and Gauss Divergence Theorem Line integrals, Applications of line integrals: Mass and Work, Fundamental theorem for line integrals, Conservative vector fields, Green's theorem, Area as a line integral, Surface integrals, Stokes' theorem, The Gauss divergence theorem.

Text and Reference Books:

1. Jerrold Marsden, Anthony J. Tromba& Alan Weinstein (2009). Basic Multivariable Calculus, Springer India Pvt. Limited.
2. James Stewart (2012). Multivariable Calculus (7th edition).Brooks/Cole.Cengage.
3. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2011). Calculus (3rd edition).Pearson Education.Dorling Kindersley (India) Pvt. Ltd.
4. George B. Thomas Jr., Joel Hass, Christopher Heil& Maurice D. Weir (2018). Thomas' Calculus (14th edition).Pearson Education.

Semester II

CourseCode:BMC-202 Total Marks: 100, Credit: 6
CourseName: Ordinary Differential Equations

Course out comes(CO): At the end of the course,the student will be able to:

CO1	Students learn how to solve the first order differential equations.
CO2	Students learn how to solve the second order differential equations.
CO3	Students learn how to solve the Higher order differential equations.
CO4	Students learn how to solve the second order differential equations by series solution and know about Legendre and Bessel functions.
CO5	Solve linear systems of ordinary differential equations

Course Details:

Unit-I: First Order Differential Equations Basic concepts and genesis of ordinary differential

equations, Order and degree of a differential equation, Differential equations of first order and first degree, Equations in which variables are separable, Homogeneous equations, Linear differential equations and equations reducible to linear form, Exact differential equations, Integrating factor, First order higher degree equations solvable for x, y and p. Clairaut's form and singular solutions. Picard's method of successive approximations and the statement of Picard's theorem for the existence and uniqueness of the solutions of the first order differential equations.

Unit-II: Second Order Linear Differential Equations Statement of existence and uniqueness theorem for linear differential equations, General theory of linear differential equations of second order with variable coefficients, Solutions of homogeneous linear ordinary differential equations of second order with constant coefficients, Transformations of the equation by changing the dependent/independent variable, Method of variation of parameters and method of undetermined coefficients, Reduction of order, Coupled linear differential equations with constant coefficients.

Unit-III: Higher Order Linear Differential Equations Principle of superposition for a homogeneous linear differential equation, Linearly dependent and linearly independent solutions on an interval, Wronskian and its properties, Concept of a general solution of a linear differential equation, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler-Cauchy equation, Method of variation of parameters and method of undetermined coefficients, Inverse operator method.

Unit-IV: Series Solutions of Differential Equations Power series method, Legendre's equation, Legendre polynomials, Rodrigue's formula, Orthogonality of Legendre polynomials, Frobenius method, Bessel's equation, Bessel functions and their properties, Recurrence relations.

Text and Reference Books:

1. Belinda Barnes & Glenn Robert Fulford (2015). Mathematical Modelling with Case Studies: A Differential Equation Approach Using Maple and MATLAB (2nd edition). Chapman & Hall/CRC Press, Taylor & Francis.
2. H. I. Freedman (1980). Deterministic Mathematical Models in Population Ecology. Marcel Dekker Inc.
3. Erwin Kreyszig (2011). Advanced Engineering Mathematics (10th edition). Wiley.

Semester II

CourseCode:GM-102 **Total Marks: 100, Credit: 6**
CourseName: Linear Algebra & Differential Equations

Course out comes(CO): At the end of the course, the student will be able to:

CO1	Solvetheconsistentsystemoflinearequations
CO2	Determinethepowerseriesexpansionofagivenfunction
CO3	Solvearbitraryorderlineardifferentialequationswithconstantcoefficients
CO4	ApplyLaplacetransformstosolvephysicalproblemsarisinginengineering
CO5	Findeigenvalues,eigenvectors&diagonalizeamatrix

Course Details:

Unit-I: Matrix Algebra: Types of matrices-Orthogonal Symmetric, Skew-Symmetric, Hermitian, Skew-Hermitian, Unitary matrices and their elementary properties, Elementary row operations and their use in finding rank, Inverse of a matrix, Solution of system of linear equations (using Rank). eigen values and eigen vectors, Cayley – Hamilton theorem, Diagonalization of a matrix.

Unit-II: Vector Space: Vector Space, linear span, basis, Linear dependence and independence of vectors, linear transformation.

Unit-III: ODE of first order: Formation of ODE, Variable separable, Homogenous differential equation, Exact, integrating factors for converting to exact differential equation, Linear differential equation and Bernoulli's differential equation.

Unit-IV: ODE of second order: Solution of linear differential equations with constant coefficients, Euler Cauchy equation, Solution by changing dependent & independent variable, Method of variation of parameters.

Unit – V: ODE of higher order: Matrix method.

Text and Reference Books:

1. E. Krezig (2005). Advance Engineering Mathematics, John Wiley & Sons.
2. B.S Grewal(2005).Higher Engineering Mathematics, Khanna Publishers.
3. G.F Simmons (1981). Differential Equations,Tata McGraw-Hill, PublishingCompany Ltd, 1981.

Semester III

CourseCode:BMC-301 **Total Marks: 100, Credit: 6**
CourseName: Real Analysis

Course out comes(CO): At the end of the course, the student will be able to:

CO1	Students learn about Set of real number and its properties.

CO2	Students learn about convergence of sequence and its properties.
CO3	Students learn about convergence of sequence and its properties.
CO4	Students learn about Riemann integration and Mean value theorem.
CO5	Apply the theory in the course to solve a variety of problems at an appropriate level of difficulty

Course Details:

Unit-I: Real Number System Algebraic and order properties of $\mathbb{R}$, Absolute value of a real number; Bounded above and bounded below sets, Supremum and infimum of a nonempty subset of $\mathbb{R}$The completeness property of $\mathbb{R}$, Archimedean property, Density of rational numbers in $\mathbb{R}$, Definition and types of intervals, Nested intervals property; Neighborhood of a point in $\mathbb{R}$, Open, closed and perfect sets in $\mathbb{R}$, Connected subsets of $\mathbb{R}$, Cantor set and Cantor function.

Unit-II: Sequences of Real Numbers Convergent sequence, Limit of a sequence, Bounded sequence, Limit theorems, Monotone sequences, Monotone convergence theorem, Subsequences, Bolzano–Weierstrass theorem for sequences, Limit superior and limit inferior of a sequence of real numbers, Cauchy sequence, Cauchy's convergence criterion.

Unit-III: Infinite Series Convergence and divergence of infinite series of positive real numbers, Necessary condition for convergence, Cauchy criterion for convergence; Tests for convergence of positive term series; Basic comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's nth root test, Integral test; Alternating series, Leibniz test, Absolute and conditional convergence, Rearrangement of series and Riemann's theorem.

Unit-IV: Riemann Integration Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, First mean value theorem, Bonnet and Weierstrass forms of second mean value theorems.

Text and Reference Books:

1. N.L Carothers, Real Analysis (2000). McGraw Hill, NY.

2. R. R. Goldberg (1976).Methods of Real Analysis, John Wiley & Sons.

3. W. Rudin (1964).Principles of Mathematical Analysis, McGraw-Hill Education.

Semester III

CourseCode:BMC-302 Total Marks: 100, Credit: 6
CourseName: Group Theory

Course out comes(CO): At the end of the course, the student will be able to:

CO1	Students learn about Group and its properties.
CO2	Students learn about Subgroup and its properties.
CO3	Students learn about Normal subgroup and its properties.
CO4	Students learn about Permutation group and its properties.
CO5	Applying the concept of a group action to real life problems such as Counting.

Course Details:

Unit-I: Groups and its Elementary Properties Symmetries of a square, Definition and examples of groups including dihedral, permutation and quaternion groups, Elementary properties of groups.

Unit-II: Subgroups and Cyclic Groups Subgroups and examples of subgroups, Cyclic groups, Properties of cyclic groups, Lagrange's theorem, Euler phi function, Euler's theorem, Fermat's little theorem.

Unit-III: Normal Subgroups Properties of cosets, Normal subgroups, Simple groups, Factor groups, Cauchy's theorem for finite abelian groups; Centralizer, Normalizer, Center of a group, Product of two subgroups; Classification of subgroups of cyclic groups.

Unit-IV: Permutation Groups Cycle notation for permutations, Properties of permutations, Even and odd permutations, alternating groups, Cayley's theorem and its applications.

Text and Reference Books:

1. Michael Artin (2014).Algebra (2nd edition). Pearson.
2. John B. Fraleigh (2007).A First Course in Abstract Algebra (7th edition), Pearson.
3. Joseph A. Gallian (2017).Contemporary Abstract Algebra (9th edition).Cengage.
4. I. N. Herstein (2006).Topics in Algebra (2nd edition).Wiley India, 2006.
5. Nathan Jacobson (2009).Basic Algebra I (2nd edition).Dover Publications.
6. RamjiLal (2017).Algebra 1: Groups, Rings, Fields and Arithmetic, Springer.
7. I.S. Luthar& I.B.S. Passi (2013). Algebra: Volume 1: Groups,Narosa.

Semester III

CourseCode:BMC-303 Total Marks: 100, Credit: 6
CourseName: Probability and Statistics

Course out comes(CO): At the end of the course,the student will be able to:

CO1	Students learn about the basic concept of probability with application.
CO2	Students learn about random variable and distribution functions.
CO3	Students learn about different types of standard distribution functions.
CO4	Students learn about Correlation, regression and concept of central limit theorem.
CO5	Derive the probability density function of transformation of random variables

Course Details:

Unit-I: Probability Functions and Moment Generating Function Basic notions of probability, Conditional probability and independence, Baye's theorem.

Unit II: Random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions; Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function.

Unit-III: Univariate Discrete and Continuous Distributions Discrete distributions: Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions: Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution.

Unit-IV: Correlation, Regression and Central Limit Theorem The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables, Linear regression for two variables, The method of least squares, Bivariate normal distribution, Chebyshev's theorem, Strong law of large numbers, Central limit theorem and weak law of large numbers.

Text and Reference Books:

1. Robert V. Hogg, Joseph W. McKean & Allen T (2013). Craig, Introduction to Mathematical Statistics (7th edition), Pearson Education.
2. Irwin Miller &Marylees Miller, John E. Freund's (2014). Mathematical Statistics with Applications (8thedition). Pearson. Dorling Kindersley Pvt. Ltd. India.
3. Jim Pitman, Probability, Springer-Verlag.
4. Sheldon M. Ross (2014).Introduction toProbability Models (11th edition).Elsevier.
5. A. M. Yaglom and I. M. Yaglom (1983). Probability and Information. D. Reidel Publishing Company. Distributed by Hindustan Publishing Corporation (India) Delhi.

Semester III

CourseCode:GM-103 Total Marks: 100, Credit: 6
CourseName: Integral Transforms

Course out comes(CO): At the end of the course, the student will be able to:

CO1	Have understanding regarding different kind of integral transforms.
CO2	Understand Fourier transform and its properties and will be able to solve the examples based on it.
CO3	Have deep understanding of Laplace Transformation and its real life application.
CO4	Solve initial value problem and boundary value problem using Laplace Transform..
CO5	Solve initial value problem and boundary value problem using Laplace Transform.

Course Details:

Unit I: Laplace Transform: Existence of Laplace Transform, Function of exponential order, a function of Class A, Laplace Transform of some elementary function, First and Second translation, change of scale property, Laplace transform of the derivative, Laplace transform of Integral, Multiplication, Division, Periodic function.

Unit-II: Inverse Laplace Transform: Null Function, Lerch's Theorem, first and second Translation, Change of scale, Derivatives, Integrals, Multiplication, Division, Convolution Theorem, Heaviside's expansion, The complex inversion formula.

Unit-III: Applications: Solution of Ordinary Differential equations. Solution of Simultaneous Ordinary differential equation.

Unit-IV: Fourier Transform: Fourier Transform, Convolution, Relation between Fourier and Laplace Transform, Parseval's Identity for Fourier Transform, Fourier Transform of derivative of function, Finite Fourier Transform.

Unit-V: Application of Fourier transform: Solution of Initial and Boundary value problems using Fourier transform and finite Fourier Transform.

Text and Reference Books:

1. Ian N Senddon (1972), The Use of Integral Transform, McGraw Hill.

2. L. Dobanth and D. Bhatta, Integral Transforms and Their Applications, 2nd edition, Taylor and Francis Group.

3. E. Kreyszig (2011), Advanced Engineering Mathematics, John Wiley & Sons.

Semester IV

CourseCode:BMC-401 Total Marks: 100, Credit: 6
CourseName: Mechanics

Course out comes (CO): At the end of the course,the student will be able to:

CO1	The linear momentum principle: Linear momentum, linear momentum principle, motion of the center of mass, conservation of linear momentum.
CO2	The angular momentum principle: Moment of a force about a point, about an axis. Angular momentum about a point, about an axis. Angular momentum principle about center of mass. Conservation of angular momentum (about a point and an axis). Impulsive forces.
CO3	The energy principle: Configurations and degrees of freedom of a multi-particle system, energy principle, energy conservation.
CO4	Rocket motion in free space and under gravity, collision of elastic bodies. The two-body problem.
CO5	Degrees of freedom and motion parameters, gear trains, dimensions of mechanisms.

Course Details:

Unit-I: Statics Equilibrium of a particle, Equilibrium of a system of particles, Necessary conditions of equilibrium, Moment of a force about a point, Moment of a force about a line, Couples, Moment of a couple, Equipollent system of forces, Work and potential energy, Principle of virtual work for a system of coplanar forces acting on a particle or at different points of a rigid body, Forces which can be omitted in forming the equations of virtual work.

Unit-II: Centres of Gravity and Common Catenary Centres of gravity of plane area including a uniform thin straight rod, triangle, circular arc, semicircular area and quadrant of a circle, Centre of gravity of a plane area bounded by a curve, Centre of gravity of a volume of revolution; Flexible strings, Common catenary, Intrinsic and Cartesian equations of the common catenary, Approximations of the catenary.

Unit-III: Rectilinear Motion Simple harmonic motion (SHM) and its geometrical representation, SHM under elastic forces, Motion under inverse square law, Motion in resisting media, Concept of terminal velocity, Motion of varying mass.

Unit-IV: Motion in a Plane Kinematics and kinetics of the motion, Expressions for velocity and acceleration in Cartesian, polar and intrinsic coordinates; Motion in a vertical circle, projectiles in a vertical plane and cycloidal motion.

Text and Reference Books:

1. S. L. Loney (2006). An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies.

2. P. L. Srivatava (1964). Elementary Dynamics. Ram NarinLal, Beni Prasad Publishers Allahabad. 3. J. L. Synge & B. A. Griffith (1949).Principles of Mechanics.McGraw-Hill.

4. A. S. Ramsey (2009). Statics.Cambridge University Press.

5. A. S. Ramsey (2009). Dynamics.Cambridge University Press.

6. R. S. Varma (1962). A Text Book of Statics.Pothishala Pvt. Ltd.

Semester IV

CourseCode: BMC-402 Total Marks: 100, Credit: 6
CourseName: Linear Algebra

Course out comes (CO): At the end of the course,the student will be able to:

CO1	Understand the concepts of vector spaces, subspaces, bases, dimension and their properties.
CO2	Relate matrices and linear transformations; compute Eigen values and Eigen vectors of linear transformations.
CO3	Learn properties of inner product spaces and determine orthogonality in inner product spaces.
CO4	Realize importance of adjoint of a linear transformation and its canonical form.
CO5	Demonstrate an understanding of eigenvalues and eigenvectors.

Course Details:

Unit-I: Vector Spaces Definition and examples, Subspace, Linear span, Quotient space and direct sum of subspaces, Linearly independent and dependent sets, Bases and dimension.

Unit-II: Linear Transformations Definition and examples, Algebra of linear transformations, Matrix of a linear transformation, Change of coordinates, Rank and nullity of a linear transformation and rank-nullity theorem.

Unit-III: Further Properties of Linear Transformations Isomorphism of vector spaces, Isomorphism theorems, Dual and second dual of a vector space, Transpose of a linear transformation, Eigen vectors and Eigen values of a linear transformation, Characteristic polynomial and Cayley–Hamilton theorem, Minimal polynomial.

Unit-IV: Inner Product, orthogonality, Cauchy–Schwarz inequality, Gram–Schmidt orthogonalisation, Diagonalisation of symmetric matrices.

Text and Reference Books:

1. Stephen H. Friedberg, Arnold J. Insel& Lawrence E. Spence (2003). Linear Algebra (4thedition).Prentice-Hall of India Pvt. Ltd.

2. Kenneth Hoffman & Ray Kunze (2015).Linear Algebra (2nd edition).Prentice-Hall.

3. I. M. Gel'fand (1989). Lectures on Linear Algebra.Dover Publications.

4. Nathan Jacobson (2009). Basic Algebra I & II (2nd edition).Dover Publications.

5. Serge Lang (2005). Introduction to Linear Algebra (2nd edition).Springer India.

6. VivekSahai&VikasBist (2013).Linear Algebra (2nd Edition).Narosa Publishing House. 7. Gilbert Strang (2014). Linear Algebra and its Applications (2nd edition).Elsevier.

Semester IV

CourseCode: BMC-403 Total Marks: 100, Credit: 6
CourseName: Partial Differential Equations

Course out comes (CO): At the end of the course, the student will be able to:

CO1	Apply a range of techniques to solve first & second order partial differential equations.
CO2	Model physical phenomena using partial differential equations such as the heat and wave equations
CO3	Apply specific methodologies, techniques and resources to conduct research and produce innovative results in the area of specialization.
CO4	Extract information from partial derivative models in order to interpret reality.
CO5	Identify real phenomena as models of partial derivative equations.

Course Details:

Unit-I: First Order Partial Differential Equations Order and degree of Partial differential equations (PDE), Concept of linear and non-linear partial differential equations, Partial differential equations of the first order, Lagrange's method, Some special type of equation which can be solved easily by methods other than the general method, Charpit's general method.

Unit-II: Second Order Partial Differential Equations with Constant Coefficients Classification of linear partial differential equations of second order, Homogeneous and nonhomogeneous equations with constant coefficients.

Unit-III: Second Order Partial Differential Equations with Variable Coefficients Partial differential equations reducible to equations with constant coefficient, Second order PDE with variable coefficients, Classification of second order PDE, Reduction to canonical or normal form; Monge's method.

Unit IV: Solution of heat and wave equations in one and two dimensions by method of separation of variables.

Text and Reference Books:

1. A. S. Gupta (2004). Calculus of Variations with Applications.PHI Learning.

2. Erwin Kreyszig (2011). Advanced Engineering Mathematics (10th edition). Wiley.

3. TynMyint-U &LokenathDebnath (2013). Linear Partial Differential Equation for Scientists and Engineers (4th edition).Springer India.

4. H. T. H. Piaggio (2004). An Elementary Treatise on Differential Equations and Their Applications.CBS Publishers.

5. S. B. Rao& H. R. Anuradha (1996).Differential Equations with Applications.University Press.

6. Ian N. Sneddon (2006). Elements of Partial Differential Equations.Dover Publications.

Semester IV

CourseCode:GM-104 Total Marks:100, Credit: 6

CourseName: Statistics

Course out comes(CO): At the end of the course, the student will be able to:

CO1	With various methods of collecting data and get familiar with some elementary methods of data viz. Measures of central tendency, dispersion, skewness and kurtosis and to interpret them.
CO2	The basic concepts of probability and to find probabilities of various events
CO3	types of random variables, concepts of conditional probability andabilitytodistinguish between univariate and bivariate probability distributions;
CO4	Transformation of continuous random variable and its application.
CO5	Characteristics of random variables such as expectation, variance and also to compute various generating functions..

Course Details:

Unit-I: Descriptive Statistics: Measurement scales, primary and secondary data, Methods of Collection of primary data, methods of data representation, text, tabular, diagrammatic and graphical representation. Frequency distribution and principles governing their representation, graphical representation of frequency distributions.

Unit-II: Measures of central tendency and their properties, uses and limitations, partition values: quartiles, deciles and percentiles. Dispersion and its various measures with their properties and uses, coefficient of variation.Central and raw moments up to fourth order, skewness, kurtosis and their measures.

Unit-III: Bivariate Data: Scatter diagram, correlation, product moment correlation coefficient, regression lines and their uses, rank correlation, concept of multiple correlation and partial correlation in case of three variables.

Unit- IV: Concept of probability, classical and statistical definition of probability, additive and multiplicative theorems of probability, conditional probability and Baye's theorem. Random variable: Elementary idea of probability mass function, probability density function and distribution function. Binomial, Poisson and normal distributions with their properties and applications.

Text and Reference Books:

1. Robert.S Witte & John S. Witte, Statistics, John Wiley.

2. P.C Tulsian(2000).Business Statistics, S.Chand& company.

3. M.Spigel, L.Stephens (2018).Schaum'sOutline Statistics, McGraw-Hill.

Semester V

CourseCode:BMC-501 Total Marks: 100, Credit: 6
CourseName: Set Theory and Metric Spaces

Course out comes (CO): At the end of the course, the student will be able to:

CO1	Understand the concepts of Sets, Countable, uncountable and Partial order sets and arithmetic of cardinal numbers
CO2	To learn basic concepts in Metric Spaces
CO3	To generalize the concept of set theory and related theorems in real line to the Metric space
CO4	Explain the Continuity and uniform continuity of functions, Homeomorphism, and

	B9IKnach contraction principle.
CO5	Demonstrate the ability to solve mathematical problems in Real analysis ..

Course Details:

Unit-I: Theory of Sets Finite and infinite sets, Countable and uncountable sets, Cardinality of sets, Schröder–Bernstein theorem, Cantor's theorem, Order relation in cardinal numbers, Arithmetic of cardinal numbers, Partially ordered set.

Unit-II: Concepts in Metric Spaces Definition and examples of metric spaces, Open spheres and closed spheres, Neighborhoods, Open sets, Interior, exterior and boundary points, Closed sets, Limit points and isolated points, Interior and closure of a set, Boundary of a set, Bounded sets, Distance between two sets, Diameter of a set, Subspace of a metric space.

Unit-III: Complete Metric Spaces and Continuous Functions Cauchy and Convergent sequences, Completeness of metric spaces, Cantor's intersection theorem, Dense sets and separable spaces, Nowhere dense sets and Baire's category theorem, Continuous and uniformly continuous functions, Homeomorphism, Banach contraction principle.

Unit-IV: Compactness Compact spaces, Sequential compactness, Bolzano–Weierstrass property, Compactness and finite intersection property, Heine–Borel theorem, totally bounded sets, Equivalence of compactness and sequential compactness, Continuous functions on compact spaces.

Text and Reference Books:

1. N.L Carothers (2000). Real Analysis, McGraw Hill, NY.

2. G. F. Simmons (2004). Introduction to Topology and Modern Analysis. McGraw-Hill .

3. E. T. Copson (1988). Metric Spaces.Cambridge University Press.

4. P. K. Jain & Khalil Ahmad (2019).Metric Spaces.Narosa.

Semester V

CourseCode:BMC-502 Total Marks: 100, Credit: 6
CourseName: Advanced Algebra

Course out comes (CO): At the end of the course, the student will be able to:

CO1	Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.

CO2	Explain Demonstrate accurate and efficient use of advanced algebraic techniques.
CO3	Demonstrate capacity for mathematical reasoning through analyzing, Proving and explaining concepts from advanced algebra.
CO4	Apply problem-solving using advanced algebraic techniques applied to diverse situations in physics, engineering and other mathematical
CO5	Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.

Course Details:

Unit-I: Group Actions Group actions, Orbits and stabilizers, Conjugacy classes, Orbit-stabilizer theorem, Normalizer of an element of a group, Center of a group, Class equation of a group, Inner and outer automorphisms of a group.

Unit-II: Sylow Theorems Cauchy's theorem for finite abelian groups, Finite simple groups, Sylow theorems and applications including nonsimplicity tests.

Unit-III: Rings and Fields Definition, examples and elementary properties of rings, Commutative rings, Integral domain, Division rings and fields, Characteristic of a ring, Ring homomorphism and isomorphism, Ideals and quotient rings. Prime, principal and maximal ideals, Relation between integral domain and field, Euclidean rings and their properties, Wilson and Fermat's theorems.

Unit-IV: Polynomial Rings Polynomial rings over commutative ring and their basic properties, The division algorithm; Polynomial rings over rational field, Gauss lemma and Eisenstein's criterion, Euclidean domain, principal ideal domain, and unique factorization domain.

Unit-V: Field Extensions and Finite Fields Extension of a field, Algebraic element of a field, Algebraic and transcendental numbers, Perfect field, Classification of finite fields.

Text and Reference Books:

1. I.N Herstein, Topics in Algebra, John Wiley & Sons. New York

2. Michael Artin (2014). Algebra (2nd edition). Pearson.

3. P. B. Bhattacharya, S. K. Jain & S. R. Nagpaul (2003).Basic Abstract Algebra (2nd edition).Cambridge University Press.

4. David S. Dummit& Richard M. Foote (2008).Abstract Algebra (2nd edition).Wiley.

5. John B. Fraleigh (2007). A First Course in Abstract Algebra (7th edition). Pearson.

6. Joseph A. Gallian (2017). Contemporary Abstract Algebra (9th edition).Cengage.

Semester V

CourseCode:BMC-503 and BMC-504 (i) (Elective)
CourseName: Mathematical Logic
Total Marks: 100, Credit: 6

Course out comes(CO): At the end of the course, the student will be able to:

CO1	Understand and Analyze the Propositional Logics.
CO2	Understand the Syntax of First-order Logic, terms of languages and theory.
CO3	Prove and apply Completeness Theorem and Compactness theorem.
CO4	Understand Meta theorem in first-order logic and arithmetic.
CO5	Apply the key concepts in *logical* thinking in algebra.

Course Details:

Unit-I: Syntax of First-order Logic First-order languages, Terms of language, Formulas of language, First order theory.

Unit-II: Semantics of First-order Languages Structures of first order languages, Truth in a structure, Model of a theory, Embedding's and isomorphism.

Unit-III: Propositional Logics Syntax of propositional logic, Semantics of propositional logic, Compactness theorem for propositional logic, Proof in propositional logic, Meta theorem in propositional logic, Post tautology theorem.

Unit-IV: Proof and Meta Theorems in First-order Logic Proof in first-order logic, Meta theorems in first-order logic, some Meta theorem in arithmetic, Consistency and completeness.

Unit-V: Completeness Theorem and Model Theory Completeness theorem, Interpretation in a theory, Extension by definitions, Compactness theorem and applications, Complete theories, Applications in algebra.

Text and Reference Books:

1. Richard E. Hodel (2013). An Introduction to Mathematical Logic.Dover Publications.

2. Yu I. Manin (2010).A Course in Mathematical Logic for Mathematicians (2nd edition).Springer.

3. Elliott Mendelson (2015). Introduction to Mathematical Logic (6th edition).Chapman & Hall/CRC.

4. Shashi Mohan Srivastava (2013). A Course on Mathematical Logic (2nd edition).Springer.

Semester V

CourseCode:BMC-503 and BMC-504 (ii) (Elective)
CourseName: Integral Transforms and Fourier Analysis
Total Marks: 100, Credit: 6

Course out comes (CO): At the end of the course, the student will be able to:

CO1	The focus of this course is to familiarize the students with the concept of Fourier transform & Fourier series.
CO2	Analyze the spectral characteristics of signals using Fourier analysis.
CO3	Classify systems based on their properties and determine the response of LTI Identify system properties based on impulse response and Fourier analysis.
CO4	Apply transform techniques to analyze continuous-time and discrete-time
CO5	The students will be able to solve ordinary differential equations using Laplace transform.

Course Details:

Unit-I: Laplace Transforms Laplace transform, Linearity, Existence theorem, Laplace transforms of derivatives and integrals, Shifting theorems, Change of scale property, Laplace transforms of periodic functions, Dirac's delta function.

Unit-II: Further Properties of Laplace Transforms and Applications Differentiation and integration of transforms, Convolution theorem, Integral equations, Inverse Laplace transform, Lerch's theorem, Linearity property of inverse Laplace transform, Translations theorems of inverse Laplace transform, Inverse transform of derivatives, Applications of Laplace transform in obtaining solutions of ordinary differential equations and integral equations.

Unit-III: Fourier Transforms Fourier and inverse Fourier transforms, Fourier sine and cosine transforms, Inverse Fourier sine and cosine transforms, Linearity property, Change of scale property, Shifting property, Modulation theorem, Relation between Fourier and Laplace transforms.

Unit-IV: Solution of Equations by Fourier Transforms Solution of integral equation by Fourier sine and cosine transforms, Convolution theorem for Fourier transform, Parseval's identity for Fourier transform, Plancherel's theorem, Fourier transform of derivatives, Applications of infinite Fourier transforms to boundary value problems, Finite Fourier transform, Inversion formula for finite Fourier transforms.

Unit-V: Fourier series Fourier cosine and sine series, Fourier series, Differentiation and integration of Fourier series, Absolute and uniform convergence of Fourier series, Bessel's inequality, The complex form of Fourier series.

Text and Reference Books:

1. James Ward Brown &Ruel V. Churchill (2011).Fourier series and Boundary Value Problems.McGraw-Hill Education.

2. Charles K. Chui (1992). An Introduction to Wavelets.Academic Press.

3. Erwin Kreyszig (2011). Advanced Engineering Mathematics (10th edition). Wiley.

4. Walter Rudin (2017). Fourier Analysis on Groups. Dover Publications.

5. A. Zygmund (2002).Trigonometric Series (3rd edition).Cambridge University Press.

Semester V

CourseCode:BMC-503 and BMC-504 (iii) (Elective)
CourseName: Linear Programming
Total Marks: 100, Credit: 6

Course out comes (CO): At the end of the course, the student will be able to:

CO1	Developing skills: Mathematical background for linear programming, ability to interpret, formulate, solve and analyze linear programs arising in practical applications.
CO2	Developing knowledge base: Students will get more familiar with linear programming tools so that they can use it in their own research both in social sciences and applied sciences. The students will have a good understanding of both the theory and practice for solving linear programming problems arising in the business research.
CO3	Students will complete homework assignments, a midterm and a final exam. Lectures will be interactive with students, allowing them to interact with their peers in collaborative class discussions.
CO4	Be able to solve a linear programming problem using either the M-Method or the Two-Phase Simplex Method.
CO5	Be able to describe the Dual Theorem and its consequences.

Course Details:

Unit-I: Linear Programming Problem, Convexity and Basic Feasible Solutions Formulation, Canonical and standard forms, Graphical method; Convex and polyhedral sets, Hyperplanes, Extreme points; Basic solutions, Basic Feasible Solutions, Reduction of feasible solution to basic feasible solution, Correspondence between basic feasible solutions and extreme points.

Unit-II: Simplex Method Optimality criterion, Improving a basic feasible solution, Unboundedness, Unique and alternate optimal solutions; Simplex algorithm and its tableau format; Artificial variables, Two-phase method, Big-M method.

Unit-III: Duality Formulation of the dual problem, Duality theorems, Complimentary slackness theorem, Economic interpretation of the dual, Dual-simplex method.

Unit-IV: Sensitivity Analysis Changes in the cost vector, right-hand side vector and the constraint matrix of the linear programming problem.

Unit-V: Applications Transportation Problem: Definition and formulation, Methods of finding initial basic feasible solutions: Northwest-corner rule, Least- cost method, Vogel approximation method; Algorithm for obtaining optimal solution. Assignment Problem: Mathematical formulation and Hungarian method.

Text and Reference Books:

1. Mokhtar S. Bazaraa, John J. Jarvis &Hanif D. Sherali (2010). Linear Programming and Network Flows (4th edition).John Wiley & Sons.

2. G. Hadley (2002). Linear Programming.Narosa Publishing House.

3. Frederick S. Hillier & Gerald J. Lieberman (2015). Introduction to Operations Research (10th edition).McGraw-Hill Education.

4. Hamdy A. Taha (2017). Operations Research: An Introduction (10th edition). Pearson.

5. Paul R. Thie& Gerard E. Keough (2014).An Introduction to Linear Programming and Game Theory (3rd edition).Wiley India Pvt. Ltd.

Semester V

CourseCode:BMC-503 and BMC-504 (iv) (Elective)
CourseName: Information Theory and Coding
Total Marks: 100, Credit: 6

Course out comes (CO): At the end of the course, the student will be able to:

CO1	Understand the fundamentals of coding and decoding theory

CO2	Design and analyze the channel performance using Information theory.
CO3	Understand concept of Coding Block codes, Hamming distance, Maximum likelihood decoding.
CO4	Understand the model of communication system.
CO5	Apply logical thinking to problem solving in context of coding error correction and detection

Course Details:

Unit-I: Concepts of Information Theory Communication processes, A model of communication system, A quantitative measure of information, Binary unit of information, A measure of uncertainty, H function as a measure of uncertainty, Sources and binary sources, Measure of information for two-dimensional discrete finite probability schemes.

Unit-II: Entropy Function A sketch of communication network, Entropy, Basic relationship among different entropies, A measure of mutual information, Interpretation of Shannon's fundamental inequalities; Redundancy, efficiency, and channel capacity; Binary symmetric channel, Binary erasure channel, Uniqueness of the entropy function, Joint entropy and conditional entropy, Relative entropy and mutual information, Chain rules for entropy, Conditional relative entropy and conditional mutual information, Jensen's inequality and its characterizations, The log sum inequality and its applications.

Unit-III: Concepts of Coding Block codes, Hamming distance, Maximum likelihood decoding, Levels of error handling, Error correction, Error detection, Erasure correction, Construction of finite fields, Linear codes, Matrix representation of linear codes, Hamming codes.

Unit-IV: Bounds of Codes Orthogonality relation, Encoding and decoding of linear codes, The singleton bound and maximum distance separable codes, The sphere-packing bound and perfect codes, The Gilbert–Varshamov bound, MacWilliams' identities.

Unit-V: Cyclic Codes Definition and examples of cyclic codes, Generator polynomial and check polynomial, Generator matrix and check matrix, Bose–Chaudhuri–Hocquenghem (BCH) code as a cyclic code.

Text and Reference Books:

1. Robert B. Ash, (2014). Information Theory.Dover Publications.

2. Thomas M. Cover & Joy A. Thomas (2013).Elements of Information Theory (2nd edition).Wiley India Pvt. Ltd.

3. Joseph A. Gallian (2017). Contemporary Abstract Algebra (9th edition), Cengage.

4. Fazlollah M. Reza, (2003). An Introduction to Information Theory.Dover Publications.

5. Ron M. Roth (2007). Introduction to Coding Theory.Cambridge University Press.

6. Claude E. Shannon & Warren Weaver (1969). The Mathematical Theory of Communication.The University of Illinios Press.

Semester V

CourseCode:BMC-503 and BMC-504 (v) (Elective)
CourseName: Graph Theory
Total Marks:100, Credit: 6

Course out comes (CO): At the end of the course, the student will be able to:

CO1	Able to define the basic concepts of graphs, sub graphs, Euler and Hamiltonian graphs etc.
CO2	To understand and apply the fundamental concepts in graph theory.
CO3	To understand fundamental circuits and cut-sets, Cut-vertices, Connectivity and separability and to apply in Network flows.
CO4	To apply graph theory based tools in solving practical problems.
CO5	To prove Euler theorem for a planar graph and Kuratowski's theorem.

Course Details:

Unit-I: Paths, Circuits and Graph Isomorphisms Definition and examples of a graph, Subgraph, Walks, Paths and circuits; Connected graphs, disconnected graphs and components of a graph; Euler and Hamiltonian graphs, Graph isomorphisms, Adjacency matrix and incidence matrix of a graph, Directed graphs and their elementary properties.

Unit-II: Trees and Fundamental Circuits Definition and properties of trees, Rooted and binary trees, Cayley's theorem on a counting tree, Spanning tree, Fundamental circuits, Minimal spanning trees in a connected graph.

Unit-III: Cut-Sets and Cut-Vertices Cut-set of a graph and its properties, Fundamental circuits and cut-sets, Cut-vertices, Connectivity and separability, Network flows, 1- isomorphism and 2- isomorphism.

Unit-IV: Planar Graphs Planar graph, Euler theorem for a planar graph, Various representations of a planar graph, Dual of a planar graph, Detection of planarity, Kuratowski's theorem.

Text and Reference Books:

1. R. Balakrishnan& K. Ranganathan (2012).A Textbook of Graph Theory.Springer.

2. NarsinghDeo (2016). Graph Theory with Applications to Engineering and Computer Science. Dover Publications.

3. ReinhardDiestel (2017). Graph Theory (5th edition).Springer.

4. Edgar G. Goodaire& Michael M. Parmenter (2018).Discrete Mathematics with Graph Theory (3rd edition). Pearson.

5. Douglas West (2017). Introduction to Graph Theory (2nd edition). Pearson.

Semester V

CourseCode:BMC-503 and BMC-504 (vi) (Elective)
CourseName: Special Theory of Relativity
Total Marks: 100, Credit: 6

Course out comes (CO): At the end of the course, the student will be able to:

CO1	Demonstrateknowledge andbroadunderstandingofSpecial Relativity.
CO2	Explainthemeaningandsignificanceof thepostulateofSpecialRelativity.
CO3	Explaintruenatureof Lorentz transformationandDopplereffect.
CO4	Recallthe setupand significanceof Michelson-Morleyexperiment.
CO5	ExplainrelativisticmomentumandEinsteinfieldequations.

Course Details:

Unit-I: Newtonian Mechanics Inertial frames, Speed of light and Gallilean relativity, Michelson–Morley experiment, Lorentz–Fitzgerold contraction hypothesis, Relative character of space and time, Postulates of special theory of relativity, Lorentz transformation equations and its geometrical interpretation, Group properties of Lorentz transformations.

Unit-II: Relativistic Kinematics Composition of parallel velocities, Length contraction, Time dilation, Transformation equations for components of velocity and acceleration of a particle and Lorentz contraction factor.

Unit-III: Geometrical representation of space-time Four dimensional Minkowskian space-time of special relativity, Time-like, light-like and space-like intervals, Null cone, Proper time, World line of a particle, Four vectors and tensors in Minkowiskian space-time.

Unit-IV: Relativistic Mechanics Variation of mass with velocity. Equivalence of mass and energy.Transformation equations for mass momentum and energy. Energy-momentum four vector. Relativistic force and Transformation equations for its components.Relativistic equations of motion of a particle.

Text and Reference Books:

1. James L. Anderson (1973). Principles of Relativity Physics.Academic Press.

2. Peter Gabriel Bergmann (1976). Introduction to the Theory of Relativity.Dover Publications.

3. C. Moller (1972). The Theory of Relativity (2nd edition).Oxford University Press.

4. Robert Resnick (2007). Introduction to Special Relativity.Wiley.

5. Wolfgang Rindler (1977). Essential Relativity: Special, General, and Cosmological. SpringerVerlag.

6. V. A. Ugarov (1979). Special Theory of Relativity.Mir Publishers, Moscow.

Semester VI

CourseCode:BMC-601 Total Marks: 100, Credit: 6
CourseName: Complex Analysis

Course out comes (CO): At the end of the course, the student will be able to:

CO1	Understand the significance of differentiability and analyticity of complex functions leading to the Cauchy Riemann equations.
CO2	Learn the role of Cauchy Goursat theorem and Cauchy integral formula in evaluation of contour integrals.
CO3	Apply Liouville's theorem in fundamental theorem of algebra.
CO4	Understand the convergence, term by term integration and differentiation of a power series.
CO5	Learn Taylor and Laurent series expansions of analytic functions; classify the nature of singularity, poles and residues and application of Cauchy Residue theorem.

Course Details:

Unit-I: Complex Plane and functions. Complex numbers and their representation, algebra of complex numbers; Complex plane, Open set, Domain and region in complex plane; Stereographic projection and Riemann sphere; Complex functions and their limits including limit at infinity; Continuity, Linear fractional transformations and their geometrical properties.

Unit-II: Analytic Functions and Cauchy–Riemann Equations Differentiability of a complex valued function, Cauchy–Riemann equations, Harmonic functions, necessary and sufficient conditions for differentiability, Analytic functions; Analyticity and zeros of exponential, trigonometric and logarithmic functions; Branch cut and branch of multi-valued functions.

Unit-III: Cauchy's Theorems and Fundamental Theorem of Algebra Line integral, Path independence, Complex integration, Green's theorem, Anti-derivative theorem, Cauchy–Goursat theorem, Cauchy integral formula, Cauchy's inequality, Derivative of analytic function, Liouville's theorem, Fundamental theorem of algebra, Maximum modulus theorem and its consequences.

Unit-IV: Power Series Sequences, series and their convergence, Singularities, Taylor series and Laurent series of analytic functions, Power series, Radius of convergence, Integration and differentiation of power series, Absolute and uniform convergence of power series.

Text and Reference Books:

1. Lars V. Ahlfors (2017). Complex Analysis (3rd edition).McGraw-Hill Education.

2. Joseph Bak& Donald J. Newman (2010).Complex Analysis (3rd edition).Springer.

3. James Ward Brown &Ruel V. Churchill (2009).Complex Variables and Applications (9th edition).McGraw-Hill Education.

4. John B. Conway (1973). Functions of One Complex Variable.Springer-Verlag.

5. E.T. Copson (1970). Introduction to Theory of Functions of Complex Variable.Oxford University Press.

6. Theodore W. Gamelin (2001). Complex Analysis.Springer-Verlag.7. George Polya& Gordon Latta (1974).Complex Variables.Wiley.

Semester VI

CourseCode:BMC-602 Total Marks: 100, Credit: 6
CourseName: Numerical Analysis

Course out comes (CO): At the end of the course, the student will be able to:

CO1	Obtain numerical solutions of algebraic and transcendental equations.
CO2	Find numerical solutions of system of linear equations and check the accuracy of the solutions.
CO3	Learn about various interpolating and extrapolating methods.

CO4	Solve initial and boundary value problems in differential equations using numerical methods.
CO5	Apply various numerical methods in real life problems

Course Details:

Unit-I: Numerical Methods for Solving Algebraic and Transcendental Equations Round-off error and computer arithmetic, Local and global truncation errors, Algorithms and convergence; Bisection method, False position method, Fixed point iteration method, Newton's method and secant method for solving equations.

Unit-II: Numerical Methods for Solving Linear Systems Partial and scaled partial pivoting, Lower and upper triangular (LU) decomposition of a matrix and its applications, Thomas method for tri-diagonal systems; Gauss–Jacobi, Gauss–Seidel and successive over-relaxation (SOR) methods.

Unit-III: Interpolation Lagrange and Newton interpolations, Piecewise linear interpolation, Cubic spline interpolation, Finite difference operators, Gregory–Newton forward and backward difference interpolations.

Unit-IV: Numerical Differentiation and Integration First order and higher order approximation for first derivative, Approximation for second derivative; Numerical integration: Trapezoidal rule, Simpson's rules and error analysis, Richardson extrapolation.

Unit-V: Initial and Boundary Value Problems of Differential Equations Euler's method, Runge–Kutta methods.

Text and Reference Books:

1. Brian Bradie (2006). A Friendly Introduction to Numerical Analysis. Pearson.

2. C. F. Gerald & P. O. Wheatley (2008). Applied Numerical Analysis (7th edition), Pearson Education, India.

3. F. B. Hildebrand (2013). Introduction to Numerical Analysis: (2nd edition). Dover Publications.

4. M. K. Jain, S. R. K. Iyengar& R. K. Jain (2012).Numerical Methods for Scientific and Engineering Computation (6th edition).New Age International Publishers.

5. Robert J. Schilling & Sandra L. Harris (1999).Applied Numerical Methods for Engineers Using MATLAB and C. Thomson-Brooks/Cole.

Semester VI

CourseCode:BMC-603 and BMC-604 (i) (Elective)
CourseName: Discrete Mathematics
Total Marks: 100, Credit: 6

Course out comes(CO): At the end of the course, the student will be able to:

CO1	Understand Partial order sets and Hasse diagram.
CO2	Able to understand the concept of Boolean algebra and Switching circuits.
CO3	To understand and to compute Deterministic and non deterministic finite-state automaton.
CO4	To explain Travelling salesman problem, Shortest path and Dijkstra's algorithm
CO5	Able to use logical notations to define and reason about fundamental mathematical concepts such as sets relations and functions

Course Details:

Unit-I: Partially Ordered Sets Definitions, examples and basic properties of partially ordered sets (poset), Order isomorphism, Hasse diagrams, Dual of a poset, Duality principle, Maximal and minimal elements, Least upper bound and greatest upper bound, Building new poset, Maps between posets.

Unit-II: Boolean Algebras and Switching Circuits Boolean algebras, De Morgan's laws, Boolean homomorphism, Representation theorem; Boolean polynomials, Boolean polynomial functions, Disjunctive and conjunctive normal forms, Minimal forms of Boolean polynomials, Karnaugh diagrams, Switching circuits and applications.

Unit-III: Finite-State and Turing Machines Finite-state machines with outputs, and with no output; Deterministic and nodeterministic finite-state automaton; Turing machines: Definition, examples, and computations.

Unit-IV: Graphs Definition, examples and basic properties of graphs, Königsberg bridge problem; Subgraphs, Pseudographs, Complete graphs, Bipartite graphs, Isomorphism of graphs, Paths and circuits, Eulerian circuits, Hamiltonian cycles, Adjacency matrix, Weighted graph, Travellingsalesman problem, Shortest path and Dijkstra's algorithm.

Text and ReferenceBooks:

1. B. A. Davey & H. A. Priestley (2002). Introduction to Lattices and Order (2nd edition). Cambridge University Press.

2. Edgar G. Goodaire& Michael M. Parmenter (2018).Discrete Mathematics with Graph Theory (3rd edition).Pearson Education.

3. Rudolf Lidl& Günter Pilz (1998). Applied Abstract Algebra (2nd edition). Springer.

4. Kenneth H. Rosen (2012). Discrete Mathematics and its Applications: With Combinatorics and Graph Theory (7th edition). McGraw-Hill.

5. C. L. Liu (1985). Elements of Discrete Mathematics (2nd edition).McGraw-Hill.

Semester VI

CourseCode:BMC-603 and BMC-604 (ii) (Elective)
CourseName: Number Theory
Total Marks: 100, Credit: 6

Course out comes (CO): At the end of the course, the student will be able to:

CO1	Learn about some important results in the theory of numbers including the prime number theorem, Chinese remainder theorem, Wilson's theorem and their consequences.
CO2	Learn about number theoretic functions, modular arithmetic and their applications.
CO3	Familiarize with modular arithmetic and find primitive roots of prime and composite numbers.
CO4	Know about open problems in number theory, namely, the Goldbach conjecture and twin-prime conjecture.
CO5	Apply public crypto systems, in particular, RSA

Course Details:

Unit-I: Distribution of Primes and Theory of Congruencies Linear Diophantine equation, Prime counting function, Prime number theorem, Goldbach conjecture, Twin-prime conjecture, Odd perfect numbers conjecture, Fermat and Mersenne primes, Congruence relation and its properties, Linear congruence and Chinese remainder theorem, Fermat's little theorem, Wilson's theorem.

Unit-II: Number Theoretic Functions Number theoretic functions for sum and number of divisors, Multiplicative function, The Möbius inversion formula, Greatest integer function, Euler's phi-function and properties, Euler's theorem.

Unit-III: Primitive Roots Order of an integer modulo n, Primitive roots for primes, Composite numbers having primitive roots; Definition of quadratic residue of an odd prime, Euler's criterion.

Unit-IV: Quadratic Reciprocity Law The Legendre symbol and its properties, Quadratic reciprocity, Quadratic congruencies with composite moduli.

Text and Reference Books:

1. David M. Burton (2007). Elementary Number Theory (7th edition).McGraw-Hill. UGC DOCUMENT ON LOCF MATHEMATICS 58

2. Gareth A. Jones & J. Mary Jones (2005). Elementary Number Theory.Springer.

3. Neville Robbins (2007). Beginning Number Theory (2nd edition). Narosa.

4. I.Niven (2012). An Introduction to the Theory of Numbers (5th edition).John Wiley & Sons.

5. Neal Koblitz (1994). A Course in Number Theory and Cryptography (2nd edition).Springer.

Semester VI

CourseCode:BMC-603 and BMC-604 (iii) (Elective)
CourseName: Mathematical Finance
Total Marks: 100, Credit: 6

Course out comes (CO): At the end of the course, the student will be able to:

CO1	To understand Basic Theory of Interest and Fixed-Income Securities Principal.
CO2	To understand Term Structure of Interest Rates, Bonds, Exchange-traded markets.
CO3	Employ methods related to these concepts in a variety of financial applications.
CO4	To understand the Stock Prices and Black Scholes Model Binomial option pricing model.
CO5	Understand the standard and advanced quantitative methodologies and techniques of importance to a range of careers in investment banks and other financial institutions.

Course Details:

Unit-I: Basic Theory of Interest and Fixed-Income Securities Principal and interest: simple, compound and continuous; Present and future value of cash flow streams; Net present value, Internal rates of return and their comparison; Inflation, Annuities; Bonds, Bond prices and yields, Macaulay duration and modified duration.

Unit-II: Term Structure of Interest Rates, Bonds and Derivatives Spot rates, forward rates and explanations of term structure; Running present value, Floatingrate bonds, Immunization, Convexity; Putable and callable bonds; Exchange-traded markets and over-the-counter markets; Derivatives: Forward contracts, Future contracts, Options, Types of traders, Hedging, Speculation, Arbitrage.

Unit-III: Mechanics of Options Markets No-arbitrage principle, Short selling, Forward price for an investment asset; Types of options: Call and put options, Option positions, Underlying assets, Factors affecting option prices, Upper and lower bounds for option prices, Put-call parity, Effect of dividends.

Unit-IV: Stochastic Analysis of Stock Prices and Black–Scholes Model Binomial option pricing model, Risk neutral valuation: European and American options on assets following binomial tree model; Lognormal property of stock prices, Distribution of rate of return, Expected return, Volatility, Estimating volatility from historical data, Extension of risk-neutral valuation to assets following geometric Brownian motion, Black–Scholes formula for European options.

Unit-V: Hedging Parameters, Trading Strategies and Swaps Hedging parameters: Delta, gamma, theta, rho and vega; Trading strategies involving options, Swaps, Mechanics of interest rate swaps, Comparative advantage argument, Valuation of interest rate swaps, Currency swaps, Valuation of currency swaps.

Text and Reference Books:

1. John C. Hull &SankarshanBasu (2018).Options, Futures and Other Derivatives (10th edition).Pearson Education.

2. David G. Luenberger (2013). Investment Science (2nd edition).Oxford University Press.

3. Sheldon M. Ross (2011). An Elementary Introduction to Mathematical Finance (3rd edition).Cambridge University Press.

Semester VI

CourseCode:BMC-603 and BMC-604 (iv) (Elective)
CourseName: C++Programming for Mathematics
Total Marks: 100, Credit: 6

Course out comes(CO): At the end of the course,the student will be able to:

CO1	Understand and apply the programming concepts of C++ which is important for mathematical investigation and problem solving.
CO2	Use mathematical libraries for computational objectives.
CO3	Represent the outputs of programs visually in terms of well formatted text and plots.
CO4	Describe the concept of function overloading, operator overloading, virtual functions and polymorphism.
CO5	Classify inheritance with the understanding of early and late binding, usage of exception handling, generic programming.

Course Details:

Unit-I: C++ Essentials Fundamentals of programming, Organization of logic flow in stored program model of computation, C++ as a general purpose programming language, Structure of a C++ program, Common compilers and IDE's, Basic data-types, Variables and literals in C++, Operators, Expressions, Evaluation precedence and type compatibility; Outline of program development in C++, Debugging and testing; Applications: Greatest common divisor and random number generation.

Unit-II: Structured Data Structured data-types in C++, Arrays and manipulating data in arrays; Objects and classes: Information hiding, modularity, constructors and destructors, methods and polymorphism; Applications: Factorization of an integer, Euler's totient, Images in Cartesian geometry using points in two & three dimensions, Pythagorean triples.

Unit-III: Containers and Templates Containers and Template Libraries: Sets, iterators, multisets, vectors, maps, lists, stacks and queues; Applications: Basic set algebra, modulo arithmetic and congruence's, projective plane, permutations, monotone sequences and polynomials.

Text and Reference Books:

1. Nell Dale & Chip Weems (2013).Programming and Problem Solving with C++ (6th edition). Jones & Bartlett Learning.

2. Peter Gottschling (2016). Discovering Modern C++: An Intensive Course for Scientists, Engineers, and Programmers. Pearson.

3. Nicolai M. Josuttis (2012). The C++ Standard Library: A Tutorial and Reference (2nd edition). Addison-Wesley, Pearson.

4. Donald E. Knuth (1968). The Art of Computer Programming.Addison-Wesley.

Semester VI

CourseCode:BMC-603 and BMC-604 (v) (Elective)
CourseName: Cryptography
Total Marks: 100, Credit: 6

Course out comes (CO): At the end of the course, the student will be able to:

CO1	Understand the fundamental concepts of cryptography.
CO2	Describe the difference among symmetric, asymmetric and Public Key cryptography.
CO3	Define the basic requirements for cryptography
CO4	Apply the concepts of Encryption and Decryption.
CO5	Describe the process for implementing cryptographic systems

Course Details:

Unit I: Introduction to Cryptography and Classical Cryptography Cryptosystems and basic cryptographic tools: Secret-key cryptosystems, Public-key cryptosystems, Block and stream ciphers, Hybrid cryptography, Message integrity: Message authentication codes, Signature schemes, Nonrepudiation, Certificates, Hash functions, Cryptographic protocols, Security; Hybrid cryptography: Message integrity, Cryptographic protocols, Security, Some simple cryptosystems, Shift cipher, Substitution cipher, Affine cipher, Vigenère cipher, Hill cipher, Permutation cipher, Stream ciphers, Cryptanalysis of affine, substitution, Vigenère, Hill and LFSR stream ciphers.

Unit-II: Cryptographic Security, Pseudo Randomness and Symmetric Key Ciphers Shannon's theory, Perfect secrecy, Entropy, Spurious keys and unicity distance; Bit generators, Security of pseudorandom bit generators. Substitution-permutation networks, Data encryption standard (DES), Description and analysis of DES; Advanced encryption standard (AES), Description and analysis of AES; Stream ciphers, Trivium.

Unit-III: Basics of Number Theory and Public-Key Cryptography Basics of number theory; Introduction to public-key cryptography, RSA cryptosystem, Implementing RSA; Primality testing, Legendre and Jacobi symbols, Solovay–Strassen algorithm, Miller–Rabin algorithm; Square roots modulo n, Factoring algorithms, Pollard $p - 1$ algorithm, Pollard rho algorithm, Dixon's random squares algorithm, Factoring algorithms in practice; Rabin cryptosystem and its security.

Unit-IV: More on Public-Key Cryptography Basics of finite fields; ElGamal cryptosystem, Algorithms for the discrete logarithm problem, Shanks' algorithm, Pollard rho discrete logarithm algorithm, Pohlig–Hellman UGC DOCUMENT ON LOCF MATHEMATICS 64 algorithm; Discrete logarithm algorithms in practice, Security of ElGamal systems, Bit security of discrete logarithms.

Unit-V: Hash Functions and Signature Schemes Hash functions and data integrity, SHA-3; RSA signature scheme, Security requirements for signature schemes, Signatures and Hash functions, ElGamal signature scheme, Security of ElGamal signature scheme, Certificates.

Text and Reference Books:

1. Jeffrey Hoffstein, Jill Pipher& Joseph H. Silverman (2014). An Introduction to Mathematical Cryptography (2nd edition).Springer.

2. Neal Koblitz (1994). A Course in Number Theory and Cryptography (2nd edition).Springer-Verlag.

3. ChristofPaar& Jan Pelzl (2014).Understanding Cryptography.Springer.