B.Sc. (Hon.) in Mathematics

PROGRAME’S OUTCOMES (PO’S POINTS):

The graduates will be able to:
PO 1: Science Knowledge: Apply the knowledge of Mathematical Sciences to become competent professionals at global level.

PO 2: Problem analysis: Identify, formulates and analyze scientific problems to reaching substantiated conclusions by using various areas of Mathematical Sciences.

PO 3: Design/development of solutions: Design of solutions for complex scientific problems and design of model that meet the specified needs with appropriate considerations of public health and safety and cultural, societal, and environmental considerations.

PO 4: Conduct investigations of complex problems: Use research-based methods including design of experiments, analysis and interpretation of data and synthesis of information leading to logical conclusions.

PO 5: Modern tool usage: Create, select and apply appropriate statistical and computation techniques, resources and modern tools to solve problems related to various domains like sciences, engineering etc.

PO 6: Science graduate and society: Apply reasoning within the contextual knowledge to access societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the science practices.

PO 7: Environment and sustainability: Understand the impact of the scientific solutions in the societal and environmental contexts and demonstrate the knowledge and the need for sustainable developments.

PO 8: Ethics: Apply ethical principles and responsibilities of a graduate to serve the society.

PO9: Individual and team work: Function effectively as an individual independently and as a member or leader in diverse teams and in multidisciplinary settings.

PO 10: Communication: Communicate effectively on scientific activities with the science community and with society at large such give and receive clear instructions.

PO 11: Future employability: Able to enhance skills for future employability through activities such as internships MOOCs courses, seminars, summer trainings and field projects.

PO 12: Life-long Learning: Recognize the need and have the preparation and ability to engage in independent and life-long learning in the broadest context of mathematical, statistical sciences and technological changes.

PROGRAM SPECIFIC OUTCOMES (PSO):

PSO 1: B. Sc. (Hons.) Mathematics students will be prepared to contribute effectively in areas of Geometry, Computational technique, analysis, algebra, optimization, Boolean algebra, operating systems, computer graphics and information security.

PSO 2: B. Sc. (Hons.) Mathematics students will be inculcated qualities of industry expertise, mathematical finance, finite elements and application of algebra.

PSO 3: B. Sc. (Hons.) Mathematics students will be prepared effectively in the areas of Analytic Geometry, Number Theory, Ring Theory and Actuarial Mathematics.

GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR

DEPARTMENT OF MATHEMATICS

COURSE STRUCTURE & SYLLABUS-B.Sc. (Hon.) in Mathematics

Sem	Course Type	Course Code	Course Name	Credit/Hours (L-T-P)	Marks CCA^	Marks ESE#	Total Marks
I	CORE 1	AMUATT1	Calculus	5(4-1-0)	30	70	100
	CORE 2	AMUATT2	Algebra and Geometry	5(4-1-0)	30	70	100
	GE-1		Opted from the pool Course and offered by Sister Departments	5	30	70	100
	AEC-1		Opted from the Pool Course offered by University	2	30	70	100
	SEC-1		Opted from the Pool Course offered by University	2	30	70	100
	Additional Credit Course						
			Total Credit	**19**			
II	CORE 3	AMUBTT1	Multivariable Calculus	5(4-1-0)	30	70	100
	CORE 4	AMUBTT2	Ordinary Differential Equations	5(4-1-0)	30	70	100
	GE-2		Opted from the pool Course and offered by Sister Departments	5	30	70	100
	AEC-2		Opted from the Pool Course offered by University	2	30	70	100
	SEC-2		Opted from the Pool Course offered by University	2	30	70	100
	Additional Credit Course						
			Total Credit	**19**			
III	CORE 5	AMUCTT1	Real Analysis	5(4-1-0)	30	70	100
	CORE 6	AMUCTT2	Group Theory	5(4-1-0)	30	70	100
	CORE 7	AMUCTT3	Probability and Statistics	5(4-1-0)	30	70	100
	GE-3		Opted from the pool Course and offered by Sister Departments	5	30	70	100
	AEC-3		Opted from the Pool Course offered by University	2	30	70	100
	Additional Credit Course						
			Total Credit	**22**			

IV	CORE 8	AMUDTT1	Mechanics	5(4-1-0)	30	70	100
	CORE 9	AMUDTT2	Linear Algebra	5(4-1-0)	30	70	100
	CORE 10	AMUDTT3	Partial Differential Equations and Calculus of Variations	5(4-1-0)	30	70	100
	GE-4		Opted from the pool Course and offered by Sister Departments	5	30	70	100
	AEC-4		Opted from the Pool Course offered by University	2	30	70	100
	Internship*	AMUDEF1		06			100
	Additional Credit Course						
			Total Credit	**22+6***			
V	CORE11	AMUETT1	Set Theory and Metric Spaces	5(4-1-0)	30	70	100
	CORE 12	AMUETT2	Advanced Algebra	5(4-1-0)	30	70	100
	DSE (any two)	AMUETD1	Tensors and Differential Geometry	5(4-1-0)	30	70	100
		AMUETD2	Mathematical Logic	5(4-1-0)	30	70	100
		AMUETD3	Integral Transforms and Fourier Analysis	5(4-1-0)	30	70	100
		AMUETD4	Linear Programming	5(4-1-0)	30	70	100
		AMUETD5	Information Theory and Coding	5(4-1-0)	30	70	100
		AMUETD6	Graph Theory	5(4-1-0)	30	70	100
		AMUETD7	Special Theory and Relativity	5(4-1-0)	30	70	100
	AEC-5		Opted from the Pool Course offered by University	2	30	70	100
	Additional Credit Course						
			Total Credit	**22**			
VI	CORE 13	AMUFTT1	Complex Analysis	5(4-1-0)	30	70	100
	CORE 14	AMUFTT2	Numerical Analysis	5(4-1-0)	30	70	100
	DSE (any one)	AMUFTD1	Discrete Mathematics	5(4-1-0)	30	70	100
		AMUFTD2	Wavelets and Applications	5(4-1-0)	30	70	100
		AMUFTD3	Number Theory	5(4-1-0)	30	70	100

		AMUFTD4	Mathematical Finance	5(4-1-0)	30	70	100
		AMUFTD5	C++Programming for Mathematics	5(4-1-0)	30	70	100
		AMUFTD6	Cryptography	5(4-1-0)	30	70	100
		AMUFTD7	Advanced Mechanics	5(4-1-0)	30	70	100
	Seminar	AMUFST1 ~		02			100
	Dissertation/Project	AMUFDT1 ~		07			100
	Additional Credit Course						
			Total Credit	**24**			

~The Code generated by the Department., *May be offered during the summer;
^ Continuous Comprehensive Assessment (CCA), # End-Semester Examination (ESE)

Generic Elective (GEN) offered by the Department:

	Course Type	Course Code	Course Name	Credit/Hour(L-T-P)	Marks CCA^	Marks ESE#	Total Marks
1	GE-1 (Any one)	AMUATG1	Finite Element Methods	5(4-1-0)	30	70	100
		AMUATG2	Geometry	5(4-1-0)	30	70	100
2	GE-2 (Any one)	AMUBTG1	Algebra and Matrix Theory	5(4-1-0)	30	70	100
		AMUBTG2		5(4-1-0)	30	70	100
3	GE-3 (Any one)	AMUCTG1	Differential Calculus	5(4-1-0)	30	70	100
		AMUCTG2	History of Indian Mathematics	5(4-1-0)	30	70	100
4	GE-4 (Any one)	AMUDTG1	Applications of Algebra	5(4-1-0)	30	70	100
		AMUDTG2	Combinatorial Mathematics	5(4-1-0)	30	70	100
		AMUDTG3	Theory of Equations	5(4-1-0)	30	70	100

Ability Enhancement Course (AEC) offered by the Department:

	Course Type	Course Code	Course Name	Credit/Hour (L-T-P)	Marks CCA^	Marks ESE#	Total Marks
1	AEC-1 (Any one)	AMUATA1	Set Theory and Logic	2(2-0-0)	30	70	100
		AMUATA2	Basics of Statistics	2(2-0-0)	30	70	100
2	AEC-2 (Any one)	AMUBTA1	Theory of Interpolation	2(2-0-0)	30	70	100
		AMUBTA2		2(2-0-0)	30	70	100
3	AEC-3 (Any one)	AMUCTA1	Curve Tracing	2(2-0-0)	30	70	100
		AMUCTA2		2(2-0-0)	30	70	100
4	AEC-4 (Any one)	AMUDTA1	Matrix and Determinant	2(2-0-0)	30	70	100
		AMUDTA2		2(2-0-0)	30	70	100
5	AEC-5 (Any one)	AMUETA1	Integral Transform	2(2-0-0)	30	70	100
		AMUETA2					

Skill Enhancement Course (SEC) offered by the Department:

	Course Type	Course Code	Course Name	Credit/Hour (L-T-P)	Marks CCA^	Marks ESE#	Total Marks
1	SEC-1 (Any one)	AMUATL1	Introduction to Cryptography	2(2-0-0)	30	70	100
		AMUATL2	Special Function	2(2-0-0)	30	70	100
2	SEC-2 (Any one)	AMUBTL1	Graph Theory	2(2-0-0)	30	70	100
		AMUBTL2	Linear Programming	2(2-0-0)	30	70	100

L-Lecture, T- Tutorial, P- Practical

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUATT1	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code- AMUATT1

CALCULUS

Course Objectives: The main concern of Calculus is to -

1) The goal of this course is for students to gain proficiency in calculus computations.
2) To learn three main tools for analyzing and describing the behavior of functions limits, derivatives and integral.
3) To demonstration Curvature, Asymptotes and Curve Tracing etc.
4) To lean deep knowledge geometrical interpretations.
5) To understand the tools to solve application problems in a variety of setting ranging from physics and biology to business and economics etc.

Unit-I: Sequences and Integration

Real numbers, Sequences of real numbers, Convergence of sequences and series, Bounded and monotonic sequences; Definite integral as a limit of sum, Integration of irrational algebraic functions and transcendental functions, Reduction formulae, Definite integrals.

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; Darboux's theorem, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Geometrical interpretation of mean value theorems; 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, Tangents at origin, Multiple points, Position and nature of double points; Tracing of Cartesian, polar and parametric curves.

References:

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

WileyIndia.
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* (19^{th} edition). Pothishala Pvt. Ltd.
5. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018), *Thomas*' *Calculus* (14^{th} edition), Pearson Education.

Course Outcomes: This course will enable the students to -

1) Assimilate the notions of limit of a sequence and convergence of a series of realnumbers.
2) Calculate the limit and examine the continuity of a function at a point.
3) Understand the consequences of various mean value theorems for differentiablefunctions.
4) Sketch curves in Cartesian and polar coordinate systems.
5) Apply derivative tests in optimization problems appearing in social sciences, physicalsciences, life sciences and a host of other disciplines.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2				2							1		
CO2	3	2				2							1		
CO3	3	2				2							1		
CO4	3	2				2							1		
CO5	3	2				2							1		

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUATT2	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code- AMUATT2

ALGEBRA AND GEOMETRY

Course Objective: The objective of this course is -

1) To learn various techniques to find roots of the polynomial equations and to apply De Moivre's theorems.
2) To understand about set, relation, functions and basic concepts of number theory.
3) To familiarize basic properties of matrices and idea about Cayley Hamilton Theorem
4) To give basic ideas about geometry of planes, straight lines and spheres.
5) To give basic ideas about geometry conic sections.

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 n^{th} 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 congruence's; 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; 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.

Unit-IV: Planes, Straight Lines and Spheres

Planes: Distance of a point from a plane, Angle between two planes, pair of planes, Bisectors of angles between two planes; Straight lines: Equations of straight lines, Distance of a point from a straight line, Distance between two straight lines, Distance between a straight line and a plane; Spheres: Different forms, Intersection of two spheres, Orthogonal intersection, Tangents and normal, Radical plane, Radical line, Coaxial system of spheres, Pole, Polar and Conjugacy.

Unit-V: Locus, Surfaces, Curves and Conicoids

Space curves, Algebraic curves, Ruled surfaces, some standard surfaces, Classification of quadric surfaces, Cone, Cylinder, Central conicoids, Tangent plane, Normal, Polar planes, and Polar lines.

References:

1. Titu Andreescu & Dorin Andrica (2014). *Complex Numbers from A to...Z.* (2nd edition). Birkhäuser.
2. Robert J. T. Bell (1994). *An Elementary Treatise on Coordinate Geometry of ThreeDimensions*. Macmillan India Ltd.
3. D. Chatterjee (2009). *Analytical Geometry: Two and Three Dimensions*. NarosaPublishing House.
4. Leonard Eugene Dickson (2009). *First Course in the Theory of Equations*. TheProject Gutenberg EBook (http://www.gutenberg.org/ebooks/29785).
5. Edgar G. Goodaire & Michael M. Parmenter (2015). *Discrete Mathematics withGraph Theory* (3rd edition). Pearson Education Pvt. Ltd. India.
6. Bernard Kolman & David R. Hill (2003). *Introductory Linear Algebra with Applications* (7th edition). Pearson Education Pvt. Ltd. India.
7. David C. Lay, Steven R. Lay & Judi J. McDonald (2016). *Linear Algebra and itsApplications* (5th edition), Pearson Education Pvt. Ltd. India.

Course Outcomes: After completions of this course, students will be able -

1) To solve the polynomial equations and to apply De Moivre’s theorems.
2) To distinguish between relations, function and Tell about concepts of number theory.
3) To find various type of problems related with matrices, and solve system of linear equations.
4) To solve geometrical calculation regarding planes, straight lines, and spheres.
5) To identify conics with their geometrical shapes.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	3					2	1	1	2	1		3
CO2	3	2	1	2					3	1	1	2	2		3
CO3	3	3	1	3					2	2	1	2	1		3
CO4	3	3	2	3					3	1	1	2	1		3
CO5	3	3	2	3					3	1	1	2	1		3

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUBTT1	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code-AMUBTT1

MULTIVARIABLE CALCULUS

Course Objectives: The objective of this course is -

1) Learn conceptual variations while advancing from one variable to several variables in calculus.
2) To understand about the concepts higher order differential equation.
3) To understand the concepts of to find maxima and minima of the functions two and more variables.
4) To understand the conceptions double and triple integration with their geometrical meaning.
5) To understand Green's, Stokes' and Gauss Divergence Theorem and line, surface and volume integral.

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 ofvariables, Euler's theorem for homogeneous functions, Taylor's theorem for functions of twovariables and more variables, Envelopes and evolutes.

Unit-III: Extrema 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 andvector identities.

Unit-IV: Double and Triple Integrals

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

Unit-V: Green's, Stokes' and Gauss Divergence Theorem

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

References:

1. Jerrold Marsden, Anthony J. Tromba & Alan Weinstein (2009). *Basic MultivariableCalculus*, 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.

Course Outcomes: This course will enable the students to -

1) Learn conceptual variations while advancing from one variable to several variables in calculus.
2) Apply multivariable calculus in optimization problems.
3) Inter-relationship amongst the line integral, double and triple integral formulations.
4) Applications of multivariable calculus tools in physics, economics, optimization, and understanding the architecture of curves and surfaces in plane and space etc.
5) Realize importance of Green, Gauss and Stokes' theorems in other branches.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2		2	2								3		
CO2	3	2		2	2								3		
CO3	3	2		2	2								3		
CO4	3	2		2	2								3		
CO5	3	2		2	2								3		

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUBTT2	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code- AMUBTT2

ORDINARY DIFFERENTIAL EQUATIONS

Course Objectives: The objective of this course is –

1) The goal of this course is for students to gain proficiency in ordinary differential equation computations.
2) To learn three main tools for analyzing and describing the behavior of functions first order, and second order and higher order etc.
3) To demonstration various method like as Picard's method Power series method and Bessel's equations etc.
4) To understand the tools to solve the problems in variety of setting ranging from Physics and Biology etc.
5) Application of ODE in orthogonal trajectories, Acceleration-Velocity model, LCR-Circuits, and Lokta- Volterra population model etc.

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.

Unit-V: Applications

Orthogonal trajectories, Acceleration-velocity model, Minimum velocity of escape from Earth's gravitational field, Growth and decay models, Malthusian and logistic population models, Radioactive decay, Drug assimilation into the blood of a single cold pill; Free and forced mechanical oscillations of a spring suspended vertically carrying a mass at its lowesttip, Phenomena of resonance, LCR circuits, Lotka-Volterra population model.

References:

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.
4. Daniel A. Murray (2003). *Introductory Course in Differential Equations*, Orient.
5. B. Rai, D. P. Choudhury & H. I. Freedman (2013). *A Course in Ordinary DifferentialEquations* (2nd edition). Narosa.
6. Shepley L. Ross (2007). *Differential Equations* (3rd edition), Wiley India.
7. George F. Simmons (2017). *Differential Equations with Applications and HistoricalNotes* (3rd edition). CRC Press, Taylor & Francis.

Course Outcomes: The course will enable the students to -

1) Understand the genesis of ordinary differential equations.
2) Learn various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order.
3) Know Picard's method of obtaining successive approximations of solutions of first order differential equations, passing through a given point in the plane and Power series method for higher order linear equations, especially in cases when there is no method available to solve such equations.
4) Grasp the concept of a general solution of a linear differential equation of an arbitrary order and also learn a few methods to obtain the general solution of such equations.
5) Formulate mathematical models in the form of ordinary differential equations to suggest possible solutions of the day to day problems arising in physical, chemical and biological disciplines.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2											1		
CO2	3	2											1		
CO3	3	2											1		
CO4	3	2											1		
CO5	3	2											1		

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUCTT1	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUCTT1

REAL ANALYSIS

Course Objectives: The objective of this course is –

1) To understand the basic concept of real number system and to identify the open and closed sets.
2) To examine the convergence, divergence, limit inferior and limit superior of the functions.
3) To apply the various test viz., Comparison, D'Alembert's, Cauchy and integral test for the convergence of infinite series.
4) To check the Riemann integrability of the functions.
5) To implement the test for uniform convergence.

Unit-I: Real Number System

Algebraic and order properties of ℝ, Absolute value of a real number; Bounded above and bounded below sets, Supremum and infimum of a nonempty subset of ℝ, The completeness property of ℝ, Archimedean property, Density of rational numbers in ℝ, Definition and typesof intervals, Nested intervals property; Neighborhood of a point in ℝ, Open, closed and perfect sets in ℝ, Connected subsets of 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 n^{th} 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 meanvalue theorems.

Unit-V: Uniform convergence and Improper integral:

Pointwise and uniform convergence of sequence and series of functions, Weierstrass's M-test, Dirichlet test and Abel's test for uniform convergence, Uniform convergence and continuity, Uniform convergence and differentiability, Improper integrals, Dirichlet test and Abel's testfor improper integrals.

References:

1. Robert G. Bartle & Donald R. Sherbert (2015). *Introduction to Real Analysis* (4^{th}edition).Wiley India.
2. Gerald G. Bilodeau, Paul R. Thie & G. E. Keough (2015). *An Introduction to Analysis* (2^{nd} edition), Jones and Bartlett India Pvt. Ltd.
3. K. A. Ross (2013). *Elementary Analysis***:** *The Theory of Calculus* (2^{nd} edition).Springer.

Course Outcomes: This course will enable the students to -

1) Understand many properties of the real line$\mathbb{R}$ and learn to define sequence in terms of functions from $\mathbb{R}$ to a subset of $\mathbb{R}$.
2) Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.
3) Apply the ratio, root, and alternating series and limit comparison tests for Convergence and absolute convergence of an infinite series of real numbers.
4) Learn some of the properties of Riemann Integrable functions, and the applications of the fundamental theorems of integration.
5) Understand the concept of sequence and series of functions.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3		2	2	1			1			2	3	1	3
CO2	3	3		2	2	1			1			2	3	1	3
CO3	3	3		2	2	1			1			2	3	1	3
CO4	3	3		2	2	1			1			2	3	1	3
CO5	3	3		2	2	1			1			2	3	1	3

Weightage: 1-Slightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUCTT2	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code – AMUCTT2

GROUP THEORY

Course Objectives: The objective of this course is –

1) To learn Basic concept of group theory and it properties.
2) To learn Subgroup and cyclic group.
3) To understand the Normal subgroup and permutation group.
4) Demonstrate the Ring and Fields.
5) To understand the group homomorphism, Cayley's theorem and its applications

Unit-I: Groups and its Elementary Properties

Symmetries of a square, Definition and examples of groups including dihedral, permutationand 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.

Unit-V: Group Homomorphisms, Rings and Fields

Group homomorphisms, Properties of homomorphisms, Group isomorphisms, Properties of isomorphisms; First, second and third isomorphism theorems for groups; Definitions and elementary properties of rings and fields.

References:

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

Course Outcomes: The course will enable the students to:

1) Recognize the mathematical objects called groups.
2) Link the fundamental concepts of groups and symmetries of geometrical objects.

3) Explain the significance of the notions of cosets, normal subgroups, and factor groups.
4) Analyze consequences of Lagrange's theorem.
5) Learn about structure preserving maps between groups and their consequences.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2						1	1	1	2	2	2
CO2	3	3	2	2						1	1	1	2	2	2
CO3	3	3	2	2						1	1	1	2	2	2
CO4	3	3	2	2						1	1	1	2	2	2
CO5	3	3	2	2						1	1	1	2	2	2

Weightage: 1-Slightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUCTT3	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUCTT3

PROBABILITY AND STATISTICS

Course Objectives: This course will enable the students to:

1) Understand distributions in the study of the joint behavior of two random variables.
2) Establish a formulation helping to predict one variable in terms of the other variable using the technique of correlation and linear regression.
3) Understand central limit theorem, which establish the remarkable fact that the empirical frequencies of so many natural populations, exhibit a bell shaped curve.
4) Translate real-world problems into probability models.
5) Learn the process of measuring the uncertainty of a random experiment.

Unit-I: Probability Functions and Moment Generating Function
Basic notions of probability, Conditional probability and independence, Baye's theorem; Random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions; Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function.

Unit-II: 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-III: Bivariate Distribution
Joint cumulative distribution function and its properties, Joint probability density function, Marginal distributions, Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations.

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, Themethod of least squares, Bivariate normal distribution, Chebyshev's theorem, Strong law oflarge numbers, Central limit theorem and weak law of large numbers.

Unit-V: Modeling Uncertainty
Uncertainty, Information and entropy, Uniform Priors, Polya's urn model and random graphs.

References:

1. Robert V. Hogg, Joseph W. McKean & Allen T. Craig (2013). *Introduction toMathematical Statistics* (7th edition), Pearson Education.
2. Irwin Miller & Marylees Miller (2014). *John E. Freund's Mathematical Statistics with Applications* (8thedition). Pearson. Dorling Kindersley Pvt. Ltd. India.
3. Jim Pitman (1993). *Probability*, Springer-Verlag.
4. Sheldon M. Ross (2014). *Introduction to Probability 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.

Course Outcomes: Upon successful completion of this course, students will be able to –

1) Use the basic probability rules, including additive and multiplicative laws, using the terms, independent and mutually exclusive events.
2) Identify the type of statistical situation to which different probability distributions can be applied.
3) Use discrete and continuous probability distributions to solve statistical problems and make decisions.
4) Calculate and interpret the correlation between two variables and employee the principles of linear regression and correlation, predicting a particular value of Y for a given value of X and significance of the correlation coefficient.
5) Evaluate the degree of uncertainty of experiments.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	1	3	3	1		2	3	3	3	2		
CO2	3	2	2	3		2	1		1	1	2	3	2		
CO3	3	3	2	2	3	3	3		3	3	3	3	2		
CO4	3	3	3	3	3	3	3		3	3	3	3	2		
CO5	3	3	3	3	3	3	3		3	3	3	3	2		

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUDTT1	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUDTT1

MECHANICS

Course Objectives: Objective of the course is to make Students will able -

1) To familiarize basic concept of equilibrium of a particle in statics.
2) To understand of centre of gravity and common catenary of various plane areas.
3) To learn simple harmonic motion and its applications.
4) To study kinematics and kinetic motion of the particle.
5) To basic idea of equation of motion under a central force including Kepler's law of planetary motion.

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 andcycloidal motion.

Unit-V: Central Orbits

Equation of motion under a central force, Differential equation of the orbit, (p, r) equation ofthe orbit, Apses and apsidal distances, Areal velocity, Characteristics of central orbits, Kepler's laws of planetary motion.

References:

1. S. L. Loney (2006). *An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies*. Read Books.
2. P. L. Srivatava (1964). *Elementary Dynamics*. Ram Narin Lal, Beni Prasad

PublishersAllahabad.
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. Verma (1962). *A Text Book of Statics*. Pothishala Pvt. Ltd.

Course Outcomes: This course will enable the students to -

1) Familiarize with subject matter, which has been the single centre, to which were drawn mathematicians, physicists, astronomers, and engineers together.
2) Understand necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a rigid body.
3) Determine the centre of gravity of some materialistic systems and discuss the equilibrium of a uniform cable hanging freely under its own weight.
4) Deal with the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles.
5) Learn that a particle moving under a central force describes a plane curve and know the Kepler's laws of the planetary motions, which were deduced by him long before the mathematical theory given by Newton.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	1											1		
CO2	3	2											1		2
CO3	3	3			2								1		
CO4	3	2	1										1		2
CO5	3	3	1	2					2			2	2		2

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUDTT2	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUDTT2

LINEAR ALGEBRA

Course Objectives: The objective of this course is -

1) To learn about fundamental concepts of vector spaces.
2) To learn about the concepts of matrix representation of linear transformations.
3) To discuss various properties of linear transformation.
4) To give idea of inner product space.
5) To discuss few other concepts of Linear Transformation and Canonical Forms.

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 Spaces
Inner product spaces and Orthogonality, Cauchy-Schwarz inequality, Gram-Schmidt orthogonalisation, Diagonalisation of symmetric matrices.

Unit-V: Adjoint of a Linear Transformation and Canonical Forms
Adjoint of a linear operator; Hermitian, unitary and normal linear transformations; Jordan canonical form, Triangular form, Trace and transpose, Invariant subspaces.

References:

1. Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2003). *Linear Algebra* (4^{th}edition). Prentice-Hall of India Pvt. Ltd.
2. Kenneth Hoffman & Ray Kunze (2015). *Linear Algebra* (2^{nd} edition). Prentice-Hall.
3. I. M. Gel'fand (1989). *Lectures on Linear Algebra*. Dover Publications.
4. Nathan Jacobson (2009). *Basic Algebra* I & II (2^{nd} edition). Dover Publications.
5. Serge Lang (2005). *Introduction to Linear Algebra* (2^{nd} edition). Springer India.
6. Vivek Sahai & Vikas Bist (2013). *Linear Algebra* (2^{nd} Edition). Narosa PublishingHouse.
7. Gilbert Strang (2014). *Linear Algebra and its Applications* (2^{nd} edition). Elsevier.

Course Outcomes: After completions of this course, students will be able -

1) To understand the concepts of vector spaces, subspaces, bases, dimension and their properties.
2) To find matrix representation of linear transformations.
3) To understand various properties of linear transformation.
4) To understand inner product space and various proved inequalities.
5) To find various canonical forms.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1										3	3	
CO2	3	2	1										3	3	
CO3	3	2	1										3	2	
CO4	3	2	1	2									3	3	
CO5	3	2	1	1									3	3	

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUDTT3	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUDTT3

PARTIAL DIFFERENTIAL EQUATIONS AND CALCULUS OF VARIATIONS

Course Objectives: The objective of this course is -

1) Formation of the partial differential equation and to solve the PDE of first order linear and non-linear.
2) To classify the second order partial differential equations.
3) To solve the second order PDE viz., heat and wave equations using the technique of variation of separations.
4) To identify and solve the Variational problem with fixed boundary.
5) To identify and solve the Variational problem with fixed boundary.

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 thegeneral 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 non-homogeneous 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; Solution of heat and wave equations in one and two dimensions by method of separation of variables.

Unit-IV: Calculus of Variations-Variational Problems with Fixed Boundaries

Euler's equation for functional containing first order and higher order total derivatives, Functionals containing first order partial derivatives, Variational problems in parametric form, Invariance of Euler's equation under coordinates transformation.

Unit-V: Calculus of Variations-Variational Problems with Moving Boundaries:

Variational problems with moving boundaries, Functionals dependent on one and two variables, One sided variations. Sufficient conditions for an extremum-Jacobi and Legendreconditions, Second variation.

References:

1. A. S. Gupta (2004). *Calculus of Variations with Applications*. PHI Learning.
2. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10^{th} edition). Wiley.
3. Tyn Myint-U & Lokenath Debnath (2013). *Linear Partial Differential Equation forScientists and Engineers* (4^{th} edition). Springer India.
4. H. T. H. Piaggio (2004). An Elementary Treatise on *Differential Equations and*

TheirApplications. 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.

Course Outcomes: This course will enable the students to -

1) To identify the order and degree of the partial differential equations.
2) Apply a range of techniques to solve first & second order partial differential equations.
3) Model physical phenomena using partial differential equations such as the heat and wave equations.
4) Understand problems, methods and techniques of calculus of variations for fixed boundaries.
5) Understand problems, methods and techniques of calculus of variations for moving boundaries.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	3	2			1			2	3	1	2
CO2	3	3	1	2	3	2			1			2	3	1	2
CO3	3	3	1	2	3	2			1			2	3	1	2
CO4	3	3	1	2	3	2			1			2	3	1	2
CO5	3	3	1	2	3	2			1			2	3	1	2

Weightage: 1-Slightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUETT1	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUETT1

SET THEORY AND METRIC SPACES

Course Objectives: This course will enable the students to –

1) Describe memberships of sets, including the empty set, using proper notation, and decide whether given items are members and determine the cardinality of a given set.
2) Recognize when set theory is applicable to real-life situations, solve real-life problems, and communicate real-life problems and solutions to others.
3) To Understand and appreciate the concept of a metric space and be able to recognize standard examples.
4) To provide a strong foundation in basic concepts of Real Analysis this will enrich them to have a good knowledge in Pure Mathematics.
5) To impart the knowledge of Metric space, Continuity, Connectedness and Compactness.

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, Zorn's lemma and Axiom of choice, Various set theoretic paradoxes.

Unit-II: Concepts in Metric Spaces

Definition and examples of metric spaces, Open spheres and closed spheres, Neighbourhoods, 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 contractionprinciple.

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.

Unit-V: Connectedness

Separated sets, Disconnected and connected sets, Components, Connected subsets of $\mathbb{R}$, Continuous functions on connected sets.

References:

1. E. T. Copson (1988). *Metric Spaces*. Cambridge University Press.
2. P. R. Halmos (1974). *Naive Set Theory*. Springer.

3. P. K. Jain & Khalil Ahmad (2019). *Metric Spaces*. Narosa.
4. S. Kumaresan (2011). *Topology of Metric Spaces* (2nd edition). Narosa.
5. Satish Shirali & Harikishan L. Vasudeva (2006). *Metric Spaces*. Springer-Verlag.
6. Micheál O'Searcoid (2009). *Metric Spaces*. Springer-Verlag.
7. G. F. Simmons (2004). *Introduction to Topology and Modern Analysis*. Mc-Graw-Hill.

Course Outcomes: This course will enable the students to -

1) Learn basic facts about the cardinality of a set.
2) Understand several standard concepts of metric spaces and their properties like openness, closeness, completeness, Bolzano-Weierstrass property, compactness, and connectedness.
3) Identify the continuity of a function defined on metric spaces and homeomorphisms.
4) Be familiar with the fundamental notions of continuity, convergence and compactness.
5) Be able to utilize metric space arguments to obtain a variety of results.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1						2	2	1	2	1	2
CO2	3	3	2	1						2	2	1	2	1	2
CO3	3	3	2	2						2	2	2	2	1	2
CO4	3	3	2	1						2	2	2	2	1	2
CO5	3	3	2	2						2	2	2	2	1	2

Weightage: 1-Slightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUETT2	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUETT2

ADVANCED ALGEBRA

Course Objectives: On satisfying the requirements of this course, students will have the knowledge and skills to -

1) To provide a first approach to the subject of algebra, this is one of the basic pillars of modern mathematics.
2) Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.
3) Explain Demonstrate accurate and efficient use of advanced algebraic techniques.
4) Demonstrate capacity for mathematical reasoning through analyzing, Proving and explaining concepts from advanced algebra.
5) Apply problem-solving using advanced algebraic techniques applied to diverse situations in physics, engineering and other mathematical.

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 andouter 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 homomorphisms and isomorphisms, Ideals and quotient rings. Prime, principal and maximal ideals, Relation between integral domain and field, Euclidean rings and their properties, Wilson and Fermat'stheorems.

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.

References:

1. Michael Artin (2014). *Algebra* (2nd edition). Pearson.
2. P. B. Bhattacharya, S. K. Jain & S. R. Nagpaul (2003). *Basic Abstract Algebra* (2ndedition). Cambridge University Press.

3. David S. Dummit & Richard M. Foote (2008). *Abstract Algebra* (2nd edition). Wiley.
4. John B. Fraleigh (2007). *A First Course in Abstract Algebra* (7th edition). Pearson.
5. Joseph A. Gallian (2017). *Contemporary Abstract Algebra* (9th edition). Cengage.
6. N. S. Gopalakrishnan (1986). *University Algebra*, New Age International Publishers.
7. I. N. Herstein (2006). *Topics in Algebra* (2nd edition). Wiley India.
8. Thomas W. Hungerford (2004). *Algebra* (8th edition). Springer.
9. Nathan Jacobson (2009). *Basic Algebra I & II* (2nd edition). Dover Publications.
10. Serge Lang (2002). *Algebra* (3rd edition). Springer-Verlag.
11. I. S. Luthar & I. B. S. Passi (2013). *Algebra: Volume 1: Groups*. Narosa.
12. I. S. Luthar & I. B. S. Passi (2012). *Algebra: Volume 2: Rings*. Narosa.

Course Outcomes: This course will enable the students to -

1) Understand the basic concepts of group actions and their applications.
2) Recognize and use the Sylow theorems to characterize certain finite groups.
3) Know the fundamental concepts in ring theory such as the concepts of ideals, quotientrings, integral domains, and fields.
4) Understand the concept of polynomial rings, UFD, ED.
5) Learn in detail about polynomial rings, fundamental properties of finite field extensions, and classification of finite fields.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2						1	1	1	2	2	2
CO2	3	3	2	2						1	1	1	2	2	2
CO3	3	3	2	2						1	1	1	2	2	2
CO4	3	3	2	1						1	1	1	2	1	2
CO5	3	3	2	2						1	1	1	2	2	2

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUFTT1	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUFTT1

COMPLEX ANALYSIS

Course Objective: This course will enable the students to –

1) To visualize complex numbers as points of $\mathbb{R}^2$ and stereographic projection of complexplane on the Riemann sphere.
2) To understand the significance of differentiability and analyticity of complex functionsleading to the Cauchy-Riemann equations.
3) To learn the role of Cauchy-Goursat theorem and Cauchy integral formula in evaluationof contour integrals and Liouville's theorem.
4) To understand the convergence, term by term integration and differentiation of a powerseries.
5) To Learn Taylor and Laurent series expansions of analytic functions; classify the nature of singularity, poles and residues and application of Cauchy Residue theorem.

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, 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.

Unit-V: Singularities and Contour Integration
Meromorphic functions, Zeros and poles of meromorphic functions, Nature of singularities, Picard's theorem, Residues, Cauchy's residue theorem, Argument principle, Rouche's theorem, Jordan's lemma, Evaluation of proper and improper integrals.

References:

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*. OxfordUniversity Press.
6. Theodore W. Gamelin (2001). *Complex Analysis*. Springer-Verlag.
7. George Polya & Gordon Latta (1974). *Complex Variables*. Wiley.
8. H. A. Priestley (2003). *Introduction to Complex Analysis*. Oxford University Press.
9. E. C. Titchmarsh (1976). *Theory of Functions* (2nd edition). Oxford University Press.

Course Outcome: Students will try to learn –

1) The visualization of complex numbers as points of $\mathbb{R}^2$ and stereographic projection of complexplane on the Riemann sphere.
2) The significance of differentiability and analyticity of complex functions leading to the Cauchy-Riemann equations.
3) The role of Cauchy-Goursat theorem and Cauchy integral formula in evaluation of contour integrals and Liouville's theorem.
4) The convergence, term by term integration and differentiation of a powerseries.
5) Taylor and Laurent series expansions of analytic functions; classify the nature of singularity, poles and residues and application of Cauchy Residue theorem.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2						1	2	2	2	2
CO2	2	3	3	3	2						3	3	2	2	2
CO3	2	3	3	3	2						2	3	2	2	2
CO4	2	3	2	3	2						2	3	2	2	2
CO5	3	1	3	3	3						2	3	2	2	2

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUFTT2	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUFTT2

NUMERICAL ANALYSIS

Course Objectives: This course will enable the students to –

1) To solve the algebraic and transcendental equations.
2) To find the numerical solutions for the linear systems.
3) To find the Interpolation and extrapolation.
4) Numerical differentiation and integration using the numerical methods.
5) To solve the initial and boundary value problem through numerical technique.

Unit-I: Numerical Methods for Solving Algebraic and Transcendental Equations
Round-off error and computer arithmetic, Local and global truncation errors, Algorithms andconvergence; 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 tridiagonal 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 differenceinterpolations.

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, Bulirsch-Stoer extrapolation methods, Richardson extrapolation.

Unit-V: Initial and Boundary Value Problems of Differential Equations
Euler’s method, Runge-Kutta methods, higher order one step method, Multi-step methods; Finite difference method, shooting method, Real life examples: Google search engine, 1D and 2D simulations, Weather forecasting.

References:

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). DoverPublications.
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.

Course Outcomes: This course will enable the students to -

1) Obtain numerical solutions of algebraic and transcendental equations.
2) Find numerical solutions of system of linear equations and check the accuracy of the solutions.
3) Learn about various interpolating and extrapolating methods.
4) Solve initial and boundary value problems in differential equations using numerical methods.
5) Apply various numerical methods in real life problems.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	3	2			1			2	3	1	3
CO2	3	3	1	3	3	2			1			2	3	1	3
CO3	3	3	1	2	3	2			1			2	3	1	3
CO4	3	3	1	2	3	3			1			2	3	1	3
CO5	3	3	1	2	3	3			1			2	3	1	3

Weightage: 1-Slightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUETD1	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUETD1

TENSORS AND DIFFERENTIAL GEOMETRY

Course Objective: This course will enable the students to –

1) To explain the basic concepts of tensors.
2) To understand use of tensors in differential geometry.
3) To study the various types of curves and their properties also Frenet-Serret formulae and theirapplications.
4) To interpret the concept of curvature tensor, Geodesic curvature and Gauss and Weingarten formulae.
5) To learn how differential geometry involve in the solution of diverse problems in physics,engineering and in other mathematical contexts.

Unit-I: Tensors

Contravariant and covariant vectors, Transformation formulae, Tensor product of two vector spaces, Tensor of type (r, s), Symmetric and skew-symmetric properties, Contraction of tensors, Quotient law, Inner product of vectors.

Unit-II: Further Properties of Tensors

Fundamental tensors, Associated covariant and contravariant vectors, Inclination of two vectors and orthogonal vectors, Christoffel symbols, Law of transformation of Christoffel symbols, Covariant derivatives of covariant and contravariant vectors, Covariant differentiat- ion of tensors, Curvature tensor, Ricci tensor, Curvature tensor identities.

Unit-III: Curves in $\mathbb{R}^2$ and $\mathbb{R}^3$

Basic definitions and examples, Arc length, Curvature and the Frenet-Serret formulae, Fundamental existence and uniqueness theorem for curves, Non-unit speed curves.

Unit-IV: Surfaces in $\mathbb{R}^3$

Basic definitions and examples, The first fundamental form, Arc length of curves on surfaces, Normal curvature, Geodesic curvature, Gauss and Weingarten formulae, Geodesics, Parallelvector fields along a curve and parallelism.

Unit-V: Geometry of Surfaces

The second fundamental form and the Weingarten map; Principal, Gauss and mean curvatures; Isometries of surfaces, Gauss's Theorema Egregium, The fundamental theorem of surfaces, Surfaces of constant Gauss curvature, Exponential map, Gauss lemma, Geodesic coordinates, The Gauss-Bonnet formula and theorem.

References:

1. Christian Bär (2010). *Elementary Differential Geometry*. Cambridge University Press.

2. Manfredo P. do Carmo (2016). *Differential Geometry of Curves & Surfaces* (Revisedand updated 2nd edition). Dover Publications.
3. Alferd Gray (2018). *Modern Differential Geometry of Curves and Surfaces withMathematica* (4th edition). Chapman & Hall/CRC Press, Taylor & Francis.
4. Richard S. Millman & George D. Parkar (1977). *Elements of Differential Geometry*.Prentice-Hall.
5. R. S. Mishra (1965). *A Course in Tensors with Applications to Riemannian Geometry*.Pothishala Pvt. Ltd.
6. Sebastián Montiel & Antonio Ross (2009). *Curves and Surfaces*. American Mathematical Society.

Course Outcomes: This course will enable the students to –

1) Explain the basic concepts of tensors.
2) Understand role of tensors in differential geometry.
3) Learn various properties of curves including Frenet-Serret formulae and their applications.
4) Know the Interpretation of the curvature tensor, Geodesic curvature, Gauss andWeingarten formulae.
5) Apply problem-solving with differential geometry to diverse situations in physics,engineering and in other mathematical contexts.

Course Outcomes and their mapping with Programme Outcomes:

CO	**PO**												**PSO**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	2	2						2	3	3	2	1
CO2	2	3	3	3	3						3	3	3	2	1
CO3	2	2	3	2	2						2	3	2	2	1
CO4	2	2	2	3	2						2	2	3	2	1
CO5	2	3	3	2	3						2	3	3	2	1

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUETD2	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUETD2

MATHEMATICAL LOGIC

Course Objective: This course will enable the students to –

1) Understand basic concept of logic.
2) Analyze the concepts of truthiness.
3) Working of different types of logic.
4) Understand different types of theory.
5) Explore and apply key concepts in logical thinking to business problems.

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, Embeddings andisomorphism.

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.

References:

1. Richard E. Hodel (2013). *An Introduction to Mathematical Logic.* Dover Publications.
2. Yu I. Manin (2010). *A Course in Mathematical Logic for Mathematicians* (2ndedition). 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.

Course Outcomes: This course will enable the students to -

1) Learn the syntax of first-order logic and semantics of first-order languages.
2) Understand the propositional logic and basic theorems like compactness theorem.
3) To learn the Meta theorem and post-tautology theorem.
4) Assimilate the concept of completeness interpretations and their applications with special emphasis on applications in algebra.
5) Thinking about real world problems.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3											2		
CO2	3	2		3									3		
CO3	3	2		2									2		
CO4	3	3		3									2		
CO5	3	3		3									3		

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUETD3	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUETD3

INTEGRAL TRANSFORMS AND FOURIER ANALYSIS

Course Objectives: This course will enable the students to –

1) The goal of this course is for students to gain proficiency in Laplace Transform, properties and problems.
2) To learn application of Laplace Transform in obtaining solutions of Ordinary differential equations and integral equations.
3) To learn of basics Fourier Transform with properties and problems.
4) To understand solution of integral equations by Fourier transform.
5) To understand basics Fourier series and differentiation and integration of Fourier series.

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.

References:

1. James Ward Brown & Ruel V. Churchill (2011). F*ourier Series and Boundary ValueProblems*. 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.

Course Outcomes: This course will enable the students to -

1) Know about piecewise continuous functions, Dirac delta function, Laplace transforms and its properties.
2) Solve ordinary differential equations using Laplace transforms.
3) Familiarise with Fourier transforms of functions belonging to $L^1(\mathbb{R})$ class, relation between Laplace and Fourier transforms.
4) Explain Parseval's identity, Plancherel's theorem and applications of Fourier transforms to boundary value problems.
5) Learn Fourier series, Bessel's inequality, term by term differentiation and integration of Fourier series and also apply the concepts of the course in real life problems.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2											1		
CO2	3	2											1		
CO3	3	2											1		
CO4	3	2											1		
CO5	3	2											1		

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUETD4	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUETD4

LINEAR PROGRAMMING

Course Objective: This course will enable the students to –

1) To understand basic terminology &basic concepts related to linear programming problems (LPP) of real life situations.
2) To understand the few initials method for the solutions of linear programming problems.
3) To understand the duality concept of linear programming problems.
4) To know about sensitivity analysis of linear programming problems.
5) To learn about the applications of LPP for solving transportation, assignment and two-person zero-sumgame problems.

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 solutionsand 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 feasiblesolutions: Northwest-corner rule, Least- cost method, Vogel approximation method; Algorithm for obtaining optimal solution.
*Assignment Problem***:** Mathematical formulation and Hungarian method.
*Game Theory***:** Formulation and solution of two-person zero-sum games, Games with mixedstrategies, Linear programming method for solving a game.

References:

1. Mokhtar S. Bazaraa, John J. Jarvis & Hanif D. Sherali (2010). *Linear Programmingand Network Flows* (4^{th} edition). John Wiley & Sons.
2. G. Hadley (2002). *Linear Programming*. Narosa Publishing House.

3. Frederick S. Hillier & Gerald J. Lieberman (2015). *Introduction to OperationsResearch* (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 Programmingand Game Theory* (3rd edition). Wiley India Pvt. Ltd.

Course Outcome: Students will try to learn -

1) Basic understanding & terminology related to linear programming problems (LPP) of real life situations.
2) Some initials method for the solutions of linear programming problems.
3) The duality concept of linear programming problems.
4) Aware about sensitivity analysis of linear programming problems.
5) Applications of LPP for solving transportation, assignment and two-person zero-sumgame problems.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2						2	3	3	2	1
CO2	2	3	3	3	3						3	3	3	2	1
CO3	2	3	3	3	3						2	3	3	2	1
CO4	2	3	2	3	3						2	2	3	2	1
CO5	2	3	3	3	3						2	3	3	2	1

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUETD5	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUETD5

INFORMATION THEORY AND CODING

Course Objectives: The main concern of information Theory and coding is -

1) To provide an insight into the concept of information in the context of communication theory and its significance in the design of communication receivers.
2) To explore in detail, the calculations of channel capacity to support error-free transmission and also, the most commonly used source coding and channel coding algorithms.
3) To encourage and train to design coding schemes for data compression and error correction.
4) They will also get an overall perspective of how this impacts the design of an optimum communication receiver.
5) Understanding the encoding and decoding algorithms for common data compression techniques, such as Huffman coding, arithmetic coding.

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, Matrixrepresentation 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, Mac-Williams' identities.

Unit-V: Cyclic Codes

Definition and examples of cyclic codes, Generator polynomial and check polynomial, Generator matrix and check matrix, Bose Chaudhury-Hocquenghem (BCH) code as a cyclic code.

References:

1. Robert B. Ash, (2014). *Information Theory*. Dover Publications.
2. Thomas M. Cover & Joy A. Thomas (2013). *Elements of Information Theory* (2^{nd}edition). Wiley India Pvt. Ltd.
3. Joseph A. Gallian (2017). *Contemporary Abstract Algebra* (9^{th} 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.

Course Outcomes: This course will enable the students to -

1) Study simple ideal statistical communication models.
2) Understand the development of codes for transmission and detection of information.
3) Learn about the input and output of a signal via transmission channel.
4) Study detection and correction of errors during transmission.
5) Represent a linear code by matrices-encoding and decoding.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	1	1						1	1	1	2	1
CO2	3	2	2	2	1	1				1	2	2	2	1	1
CO3	3	3	1	2	2	2				1	2	1	1	1	2
CO4	3	3	1	3	2	1				2	1	2	1	3	2
CO5	3	3	1	3	3	2				1	1	2	2	2	3

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUETD6	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUETD6

GRAPH THEORY

Course Objectives: This course aims to -

1) Teach students the basic concepts and terminology of graphs, such as vertices, edges, paths, cycles, and connectivity.
2) Introduce students to the fundamental concepts of graph theory, including Eulerian and Hamiltonian graphs, planar graphs.
3) Teach students how to use graphs to model and solve real-world problems, such as shortest path problems, network flow problems, and scheduling problems.
4) Teach students about the algorithms and data structures used to manipulate and analyze graphs such as, Kuratowski's theorem, Cayley's theorem.
5) Teach students how to represent and visualize graphs using graph drawing techniques, such as force-directed layout, circular layout, and layered layout.

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 theirelementary properties.

Unit-II: Trees and Fundamental Circuits

Definition and properties of trees, Rooted and binary trees, Cayley's theorem on a countingtree, 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.

Unit-V: Graph Coloring

Chromatic number of a graph, Chromatic partition, Chromatic polynomial, Matching andcoverings, four color problem.

References:

1. R. Balakrishnan & K. Ranganathan (2012). *A Textbook of Graph Theory*. Springer.
2. Narsingh Deo (2016). *Graph Theory with Applications to Engineering and ComputerScience*. Dover Publications.
3. Reinhard Diestel (2017). *Graph Theory* (5th edition). Springer.
4. Edgar G. Goodaire & Michael M. Parmenter (2018). *Discrete Mathematics withGraph Theory* (3rd edition). Pearson.

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

Course Outcomes: This course will enable the students to:

1) Develop a solid understanding of the basic concepts and terminology of graphs, including vertices, edges, paths, cycles, and connectivity.
2) Understand the fundamental concepts of graph theory, including Eulerian and Hamiltonian graphs, planar graphs, and coloring problems.
3) Learn how to use graphs to model and solve real-world problems, such as shortest path problems, network flow problems, and scheduling problems. Develop the computational skills necessary to manipulate and analyze graphs, including the use of algorithms such as Kuratowski's theorem, Cayley's theorem and data structures such as minimum spanning tree algorithms.
4) Gain experience in graph visualization and representation using graph drawing techniques, such as force-directed layout, circular layout, and layered layout.
5) Develop problem-solving skills through practical exercises and assignments that require the application of graph theory concepts and techniques to real-world problems.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	1	1	1					1	1	1	1		1
CO2	2	2	2	1	1	1				1	1	1	2	1	
CO3	2	2	2	2	1	1				1	1	2	2	1	2
CO4	2	3	2	1	2	1				1	2	2	1	2	2
CO5	2	3	2	2	2	1				2	1	2	1	2	2

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUETD7	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUETD7

SPECIAL THEORY OF RELATIVITY

Course objective: This course aims to -

1) To analyze the basic elements of Newtonian mechanics.
2) To study about length contraction, time dilation and Lorentz contraction factor.
3) To learn 4-dimensional Minkowskian space-time and its consequences.
4) To find and study equations of motion as a part of relativistic mechanics.
5) Comparative study between relativistic mechanics and electromagnetism..

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 tensorsin 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.

Unit-V: Electromagnetism

Transformation equations for the densities of electric charge and current. Transformation equations for electric and magnetic field strengths. The Field of a Uniformly Moving Point charge. Forces and fields near a current carrying wire. Forces between moving charges. Theinvariance of Maxwell`s equations.

References:

1. James L. Anderson (1973). *Principles of Relativity Physics*. Academic Press.
2. Peter Gabriel Bergmann (1976). *Introduction to the Theory of Relativity*. DoverPublications.
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*.Springer-Verlag.
6. V. A. Ugarov (1979). *Special Theory of Relativity*. Mir Publishers, Moscow.

Course Outcomes: This course will enable the students to -

1) Understand the basic elements of Newtonian mechanics including Michelson-Morley experiment and geometrical interpretations of Lorentz transformation equations.
2) Learn about length contraction, time dilation and Lorentz contraction factor.
3) Study 4-dimensional Minkowskian space-time and its consequences.
4) Understand equations of motion as a part of relativistic mechanics.
5) Imbibe connections between relativistic mechanics and electromagnetism.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2						2	3	3	2	1
CO2	2	3	3	3	3						3	3	3	2	1
CO3	2	3	3	3	3						2	3	3	2	1
CO4	2	3	2	3	3						2	2	3	2	1
CO5	2	3	3	3	3						2	3	3	2	1

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUFTD1	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUFTD1

DISCRETE MATHEMATICS

Course Objective: This course aims to -

1) Focuses on the study of discrete structures and concepts, such as graphs, sets, logic, and algorithms. The course aims to develop students' critical thinking and problem-solving skills by exposing them to various mathematical structures and techniques used to analyze them.
2) Introduce students to fundamental concepts in discrete mathematics, such as propositional and predicate logic, set theory, graph theory, and Combinatorics. These concepts provide the foundation for further study in computer science, mathematics, and related fields.
3) Help students understand the relevance and importance of Discrete Mathematics in these fields.
4) Improve students' ability to construct and write mathematical proofs using logic and mathematical reasoning.
5) Develop students' analytical and computational skills by providing opportunities to solve problems and apply mathematical techniques to real-world problems.

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: Lattices
Lattices as posets, Lattices as algebraic structures, Sublattices, Products and homomorphisms; Definitions, examples and properties of modular and distributive lattices; Complemented, relatively complemented and sectionally complemented lattices.

Unit-III: 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, Quine-McCluskey method, Karnaugh diagrams, Switching circuits and applications.

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

Unit-V: Graphs
Definition, examples and basic properties of graphs, Königsberg bridge problem; Subgraphs, Pseudo-graphs, Complete graphs, Bipartite graphs, Isomorphism of graphs,

Paths and circuits, Eulerian circuits, Hamiltonian cycles, Adjacency matrix, Weighted graph, Travelling- salesman problem, Shortest path and Dijkstra's algorithm.

References:

1. B. A. Davey & H. A. Priestley (2002). *Introduction to Lattices and Order* (2^{nd} edition). Cambridge University Press.
2. Edgar G. Goodaire & Michael M. Parmenter (2018). *Discrete Mathematics withGraph Theory* (3^{rd} edition). Pearson Education.
3. Rudolf Lidl & Günter Pilz (1998). *Applied Abstract Algebra* (2^{nd} 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* (2^{nd} edition). McGraw-Hill.

Course Outcomes: After successful completion of this paper the students will be able to -

1) Learn about partially ordered sets, lattices and their types.
2) Understand the notion of order and maps between partially ordered sets.
3) Solve real-life problems using finite-state and Turing machines.
4) Assimilate various graph theoretic concepts and familiarize with their applications.
5) Minimize a Boolean polynomial and apply Boolean algebra techniques to decode switching circuits.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	1	1	1				1		1	1	1	2	1
CO2	3	2	2	1	1	1			2	2	1	2	2	1	2
CO3	3	3	1	2	2	2			1	1	1	1	2	1	2
CO4	3	2	2	2	2	1			1	2	2	2	1	2	2
CO5	3	3	2	2	3	2			2	2	2	3	2	2	3

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUFTD2	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUFTD2

WAVELETS AND APPLICATIONS

Course Objectives: This course aims to **-**

1) To introduce the basic idea of signal and systems.
2) To pave of the idea of Haar function and wavelets and time frequency analysis.
3) To introduce about Fourier and wavelet transform.
4) To provide the application of wavelets analysis to the real world-problems.
5) To give the application of wavelets in signal and image processing.

Unit-I: Signals and Systems

Basic concepts of signals and systems, Frequency spectrum of signals; Classification of signals: Discrete time signals and continuous time signals, periodic and non-periodic signals; Classification of systems: Linear, nonlinear, time-variant, time-invariant, stable and unstablesystems.

Unit-II: Haar Scaling Function and Wavelet, Time-Frequency Analysis

Orthogonal functions, Orthonormal functions, Function spaces, Orthogonal basis functions, Haar scaling function, Haar spaces: Haar space V_0, general Haar space V_j; Haar wavelet, Haar wavelet spaces: Haar wavelet space W_0, general Haar wavelet space W_j; Decomposition andreconstruction, Time-frequency analysis, Orthogonal and orthonormal bases.

Unit–III: Fourier Transforms and Wavelets

Discrete Fourier transform of a digital signal, Complex form of a Fourier series, Inverse discrete Fourier transform, Window Fourier transform, Short time Fourier transform, Admissibility condition for a wavelet, Classes of wavelets: Haar, Morlet, Maxican hat, Meyerand Daubechies wavelets; Wavelets with compact support.

Unit–IV: Discrete Wavelet Transforms

Stationary and non-stationary signals, Haar transform, 1-level Haar transform, Multi-level Haar transform, Conservation and compaction of energy, Multiresolution analysis, Decomposition and reconstruction of signals using discrete wavelet transform (DWT).

Unit–V: Applications

Wavelet series expansion using Haar and other wavelets, Applications in signal compression, Analysis and classification of audio signals using DWT, Signal de-noising: Image and ECGsignals.

References:

1. Charles K. Chui (1992). *An Introduction to Wavelets*. Academic Press.
2. Ingrid Daubechies (1999). *Ten Lectures on Wavelets*. SIAM.
3. Michael W. Frazier (1999). *An Introduction to Wavelets through Linear*

Algebra.Springer-Verlag.

4. Stéphane Mallat (2008). *A Wavelet Tour of Signal Processing* (3rd edition). AcademicPress.
5. M.J. Roberts (2004). *Signals and Systems: Analysis Using Transform Methods and* MATLAB. McGraw-Hill Education.
6. David K. Ruch & Patrick J. Van Fleet (2009), *Wavelet Theory*: *An ElementaryApproach with Applications*. John Wiley & Sons.
7. James S. Walker (2008). *A Primer on Wavelets and Their Scientific Applications* (2ndedition). Chapman & Hall/CRC, Taylor & Francis.

Course Outcomes: This course will enable the students to –

1) Know basic concepts of signals and systems.
2) Understand the concept of Haar spaces.
3) Learn Fourier transform and wavelet transform of digital signals.
4) Learn applications of wavelets to the real-world problems.
5) Apply wavelets in signal processing and image processing.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	2	2		2			2	3	1	3
CO2	3	3	2	2	3	2	2		1			2	3	1	3
CO3	3	3	2	2	3	2	2		1			2	3	1	3
CO4	3	3	2	2	3	3	2		1			2	3	1	3
CO5	3	3	2	2	3	3	2		1			2	3	1	3

Weightage: 1-Slightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUFTD3	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUFTD3

NUMBER THEORY

Course Objectives: This course aims to –

1) To present a rigorous development of Number Theory using axioms, definitions, examples, theorems and their proofs.
2) Identify and apply various properties of and relating to the integers including the Well-Ordering Principle, primes, unique factorization, the division algorithm, understand the concept of congruence.
3) The course aims to give elementary ideas from number theory which will have applications in cryptology.
4) To introduce arithmetical functions and explore their role in the study of distribution of primes.
5) To introduce the foundations of congruences and study the polynomial congruences, Quadratic Reciprocity Law.

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 withcomposite moduli.

Unit-V: Applications
Public key encryption, RSA encryption and decryption with applications in security systems.

References:

1. David M. Burton (2007). *Elementary Number Theory* (7th edition). McGraw-Hill.
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-Verlag.

Course Outcomes: This course will enable the students to -

1) Learn about some important results in the theory of numbers including the prime number theorem, Chinese remainder theorem, Wilson's theorem and their consequences.
2) Learn about number theoretic functions, modular arithmetic and their applications.
3) Familiarise with modular arithmetic and find primitive roots of prime and compositenumbers.
4) Know about open problems in number theory, namely, the Goldbach conjecture andtwin-prime conjecture.
5) Apply public crypto systems, in particular, RSA.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	1	2	1				2	2	2	2	2	2
CO2	3	3	3	1	2	1				2	2	2	2	1	2
CO3	3	3	3	2	2	1				2	2	2	2	1	2
CO4	3	3	3	2	2	2				2	2	2	2	1	2
CO5	3	3	3	2	2	2				2	2	2	2	1	2

Weightage: 1-Slightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUFTD4	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUFTD4

MATHEMATICAL FINANCE

Course Objectives: The student will be able -

1) To understand the similarities and differences among the main asset classes: equities, fixed income securities.
2) To internalize the concept of pricing by replication. Use pricing by replication to determine the value of forward contracts, stock options, and fixed income securities.
3) To develop short but rigorous proofs of true mathematical statements about financial models. Construct counter-examples for false statements.
4) To understand risk neutral probability measures and the fundamental theorems of asset pricing.
5) To understand the concept of Hedging so that the loss may be minimized.

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, Floating- rate 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.

References:

1. John C. Hull & Sankarshan Basu (2018). *Options, Futures and Other Derivatives* (10th edition). Pearson Education.
2. David G. Luenberger (2013). *Investment Science* (2nd edition). Oxford UniversityPress.
3. Sheldon M. Ross (2011). *An Elementary Introduction to Mathematical Finance* (3rd edition). Cambridge University Press.

Course Outcomes: This course will enable the students to:

1) Understand financial markets and derivatives including options and futures.
2) Appreciate pricing and hedging of options, interest rate swaps and no-arbitragepricing concepts.
3) Learn stochastic analysis, Ito's formula, Ito integral and the Black−Scholes model.
4) Study and use Hedging parameters, trading strategies and currency swaps.
5) Understand pros and cons of the financial market with reference to future and options.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	1	1			2	1	2	1	2	1	2
CO2	2	2	1	1	2	2			1	1	1	2	1	1	2
CO3	2	1	2	1	2	1			1	1	2	2	2	2	1
CO4	2	1	2	2	2	1			2	1	2	2	2	1	1
CO5	2	1	2	2	2	2			1	1	1	2	2	1	2

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUFTD5	4	1	0	5 HOURS	30	70	5

Paper Code - AMUFTD5

C++ PROGRAMMING FOR MATHEMATICS

Course Objectives: A course on C++ in mathematics may have the following objectives**:**

1) Introduction to programming: The course aims to introduce students to the fundamental concepts of programming using C++. This includes topics such as variables, data types, control structures, functions, and classes.
2) Applications in mathematical modelling and simulation: C++ is a powerful tool for mathematical modelling and simulation. The course aims to help students understand how to use C++ to solve mathematical problems, such as numerical analysis, optimization, and differential equations.
3) Development of computational skills: The course aims to develop students' computational skills by providing opportunities to solve mathematical problems using C++. This includes programming assignments and projects that require students to write efficient and effective code.
4) Introduction to libraries and tools: There are many libraries and tools available for C++ that is commonly used in mathematical applications, such as the Boost C++ libraries and the GNU Scientific Library. The course aims to introduce students to these libraries and tools and teach them how to use them effectively.
5) Code optimization: The course aims to teach students how to write efficient code by optimizing algorithms and data structures. This includes topics such as algorithmic complexity, memory management, and code profiling.

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 numbergeneration.

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 usingpoints 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 congruences, projective plane, permutations, monotone sequences and polynomials.

Unit-IV: Libraries and Packages
Libraries and Packages for arbitrary precision arithmetic and linear algebra**;** Features of C++ for input/output and visualization**:** Strings, streams, formatting methods, processing files in a batch, command-line arguments, visualization packages and their uses; Applications**:** Arbitrary precision arithmetic using GMP, BOOST; Finding nullity, rank, eigen values, eigen vectors, linear transformations, systems of linear equations; Plots.

Unit-V: Odds and Ends
Runtime errors and graceful degradation, Robustness in a program; Exception handling: Try- catch and throw; Defining and deploying suitable exception handlers in programs; Compiler options; Conditional compilation; Understanding and defining suitable pragmas; Applications**:** Identification and description of install parameters of mathematical libraries, debugging installation, working with multiple libraries simultaneously and maintaining correctness and consistency of data.

References:

1. Nell Dale & Chip Weems (2013).*Programming and Problem Solving with C++* (6^{th}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* (2^{nd}edition). Addison-Wesley, Pearson.
4. Donald E. Knuth (1968). *The Art of Computer Programming.* Addison-Wesley.
5. Edward Scheinerman (2006). *C++ for Mathematicians*: *An Introduction for Studentsand Professionals*. Chapman & Hall/CRC. Taylor & Francis.
6. B. Stroustrup (2013). *The C++ Programming Language* (4^{th} edition). Addison-Wesley.

Course Outcomes: Programme Specific Outcomes Students will:

1) Become technology-oriented with the knowledge and ability to develop creative solutions.
2) Better understand the effects of future developments of computer systems and technology on people and society as a whole. Acquire some development experience within a specific field of Computer Science, through project work.
3) An ability to apply knowledge of mathematics, computer science in practice. An ability to enhance not only comprehensive understanding of the theory but its application too in diverse field.
4) In order to enhance programming skills of the young IT professionals, the program has introduced the concept of project development in each language/technology learnt during semester.
5) Gain ability to communicate scientific information in a clear and concise manner.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	1	2	2	1				1			1		1
CO2	2	2	2	1	2	1					1	1	1	1	
CO3	2	2	2	1	1	1				1		1	2	1	2
CO4	2	3	3	2	2	2				1	1	2	1	2	1
CO5	2	3	2	2	3	2				1	2	1	2	2	1

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUFTD6	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUFTD6

CRYPTOGRAPHY

Course Objectives: A course on cryptography aims to introduce students to -

1) Understanding of basic cryptographic concepts: The course aims to introduce students to the basic concepts and techniques used in cryptography, including encryption, decryption, key management, and digital signatures. This includes an overview of classic and modern cryptographic algorithms and their properties.
2) Analyze cryptographic protocols for their security and privacy properties. This includes topics such as formal verification, threat modeling, and security testing.
3) Implement cryptographic algorithms using programming languages such as C++ and Python. This includes topics such as key generation, encryption, decryption, and digital signatures.
4) The applications of cryptography in various fields such as computer networks, e-commerce, and secure messaging and also, includes an overview of various standard cryptographic protocols.
5) Understanding of the challenges and issues faced by real-world cryptographic systems, such as side-channel attacks, timing attacks, and implementation flaws. This includes discussions on recent security breaches and case studies of successful and unsuccessful cryptographic implementations.

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, Cryptographicprotocols, 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 encryptionstandard (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 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.

References:

1. Jeffrey Hoffstein, Jill Pipher & Joseph H. Silverman (2014). *An Introduction toMathematical Cryptography* (2nd edition). Springer.
2. Neal Koblitz (1994). *A Course in Number Theory and Cryptography* (2nd edition).Springer-Verlag.
3. Christof Paar & Jan Pelzl (2014). *Understanding Cryptography*. Springer.
4. Simon Rubinstein-Salzedo (2018). C*ryptography*. Springer.
5. Douglas R. Stinson & Maura B. Paterson (2019). *Cryptography Theory and Practice* (4th edition)., Chapman & Hall/CRC Press, Taylor & Francis.

Course Learning Outcomes: This course will enable the students to:

1) Gain knowledge of modern cryptographic algorithms, including symmetric-key and public-key cryptography, as well as their strengths and weaknesses.
2) Understand the basic cryptographic concepts of confidentiality, integrity, authenticity, and non-repudiation, and how these concepts relate to cryptographic algorithms and protocols.
3) Learn how to analyze the security of cryptographic systems, including the identification of vulnerabilities and attacks, and the selection of appropriate cryptographic algorithms and protocols to mitigate risks.
4) Develop critical thinking and problem-solving skills through practical exercises and assignments that require the application of cryptographic concepts and techniques.
5) Develop effective communication skills through written and oral presentations of technical material related to cryptography.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	1	1	1			1	1	1	2	1	1	1
CO2	3	2	2	2	1	1			2	2	1	2	2	1	1
CO3	3	2	2	3	2	2			2	2	1	2	2	3	1
CO4	3	2	2	3	2	3			1	1	2	2	3	2	1
CO5	3	2	3	3	3	2			2	2	3	3	3	3	2

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUFTD7	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code - AMUFTD7

ADVANCED MECHANICS

Course Objectives: Objective of the course are to make Students will able -

1) To learn basic concepts of the statics forces in three dimensions in space.
2) To understand the motion of a rigid body in various coordinate systems.
3) To study the kinematics of fluid motion in Lagrangian and Eulerian approaches.
4) To familiarize Euler's and Bernoulli's equations of motion in various coordinate system.
5) To deal with two-dimensional fluid motion using the complex potential and also to understand the concepts of sources, sinks, doublets and the image systems of these with regard to a line and a circle.

Unit-I: Statics in Space
Forces in three dimensions, Reduction to a force and a couple, Equilibrium of a system of particles, Central axis and Wrench, Equation of the central axis, Resultant wrench of two wrenches; Null points, lines and planes with respect to a system of forces, Conjugate forces and conjugate lines.

Unit-II: Motion of a Rigid Body
Moments and products of inertia of some standard bodies, Momental ellipsoid, Principal axesand moments of inertia; Motion of a rigid body with a fixed point, Kinetic energy of a rigidbody with a fixed point and angular momentum of a rigid body, Euler's equations of motionfor a rigid body with a fixed point, Velocity and acceleration of a moving particle in cylindrical and spherical polar coordinates, Motion about a fixed axis, Compound pendulum.

Unit-III: Kinematics of Fluid Motion
Lagrangian and Eulerian approaches, Material and convective derivatives, Velocity of a fluidat a point, Equation of continuity in Cartesian, cylindrical polar and spherical polar coordinates, Cylindrical and spherical symmetry, Boundary surface, Streamlines and path lines, Steady and unsteady flows, Velocity potential, Rotational and irrotational motion,Vortices vector and vortex lines.

Unit-IV: Kinetics of Fluid Motion
Euler's equations of motion in Cartesian, cylindrical polar and spherical polar coordinates; Bernoulli's equation, Impulsive motion.

Unit-V: Motion in Two-Dimensions
Stream function, Complex potential, Basic singularities: Sources, sinks, doublets, complex potential due to these basic singularities; Image system of a simple source and a simple doublet with regard to a line and a circle, Milne-Thomson circle theorem.

References:

1. A. S. Ramsay (1960). *A Treatise on Hydromechanics, Part-II Hydrodynamics.* G. Bell& Sons.
2. F. Chorlton (1967). *A Textbook of Fluid Dynamics*. CBS Publishers.
3. Michel Rieutord (2015). *Fluid Dynamics An Introduction.* Springer.
4. E. A. Milne (1965). *Vectorial Mechanics*, Methuen & Co.Limited. London.

Course Outcomes: At the end of this course, the student will be able to-

1) Understand the reduction of force system in three dimensions to a resultant force acting at a base point and a resultant couple, which is independent of the choice of base of reduction.
2) Learn about a null point, a null line, and a null plane with respect to a system of forcesacting on a rigid body together with the idea of central axis.
3) Know the inertia constants for a rigid body and the equation of momental ellipsoid together with the idea of principal axes and principal moments of inertia and to derive Euler's equations of motion of a rigid body, moving about a point which is kept fixed.
4) Study the kinematics and kinetics of fluid motions to understand the equation of continuity in Cartesian, cylindrical polar and spherical polar coordinates which are used to derive Euler's equations and Bernoulli's equation.
5) Deal with two-dimensional fluid motion using the complex potential and also to understand the concepts of sources, sinks, doublets and the image systems of these with regard to a line and a circle.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1								1	2		2
CO2	3	2	1	1								1	2		2
CO3	3	2	1	3								3	2		3
CO4	3	2	1	3								3	2		3
CO5	3	2	1	1								1	2		2

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

GENERIC ELECTIVE (GEN)

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUATG1	4	1	0	5 HOURS	30	70	5

Paper Code: AMUATG1

FINITE ELEMENT METHODS

Course Objectives: The course should enable the students -

1) To learn basic principles of finite element methods.
2) To learn the theory and characteristics of finite elements used in finite element methods.
3) Formulate the design and heat transfer problems with application of finite element methods.
4) Solve 1-D, 2-D, 3-D and boundary value problems using Finite Element methods finite difference methods, a Galerkin and Ritz methods.
5) The application of the FEM technique to dynamic problems.

Introduction to finite element methods, comparison with finite difference methods, Methods of weighted residuals, collocations, least squares and Galerkin'smethod.Variational formulation of boundary value problems equivalence of Galerkin and Ritz methods.

Applications to solving simple problems of ordinary differential equations.

Linear, quadratic and higher order elements in one dimensional and assembly, solution of assembled system.

Simplex elements in two and three dimensions, quadratic triangular elements, rectangular elements, serendipity elements and isoperimetric elements and their assembly, discretization with curved boundaries

Interpolation functions, numerical integration, and modelling considerations**.**

Solution of two dimensional partial differential equations under different Geometric conditions.

Books Recommended:

1. J.N. Reddy, *Introduction to the Finite Element Methods*, Tata McGraw-Hill, 2003.
2. K.J. Bathe, *Finite Element Procedures*, Prentice-Hall, 2001**.**
3. R.D. Cook, D.S. Malkus and M.E. Plesha, *Concepts and Applications of Finite Element Analysis*, John Wiley and Sons, 2002.
4. Thomas J.R. Hughes, *The Finite Element Method: Linear Static and Dynamic Finite Element Analysis*, Dover Publication, 2000.
5. George R. Buchanan, *Finite Element Analysis*, McGraw Hill, 1994.

Course Outcomes: Upon successful completion of this course, the student will be able to -

1) Understand the numerical methods involved in Finite Element Methods.
2) Understand the role and significance of shape functions in finite element formulations and use linear, quadratic, and cubic shape functions for interpolation.
3) Understand the formulation of one-dimensional elements.
4) Understand the formulation of two-dimensional and three-dimensional elements (triangle and quadrilateral).
5) Recognize the need for life-long learning to keep abreast of new numerical analysis methods, and to enhance one's abilities as an analyst.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3									1	1	3
CO2	3	2	1	1									1	1	2
CO3	3	1	1	1									1	1	1
CO4	3	1	1	1									1	1	1
CO5	3	1	1	1									1	1	1

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUATG1	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code: AMUATG2

GEOMETRY

Course Objective: The course should enable the students -

1) To learn about fundamental idea of geometrical concept which are used frequently to understand graphical explanations.
2) Develop an idea of the generating lines.
3) Become familiar with the polar equations of conics & their tangents and normals.
4) Understand the basic applications of the analytical plane and solid geometry.
5) To study the applications of conics.

Planes, Straight Lines and Spheres: Direction cosines, direction ratios, Planes: Distance of a point from a plane, Angle between two planes, pair of planes, Bisectors of angles between two planes; Straight lines: Equations of straight lines, Distance of a point from a straight line, Distance between two straight lines, Distance between a straight line and a plane; Spheres: Different forms, Intersection of two spheres, Orthogonal intersection, Tangents and normal, Radical plane, Radical line, Coaxial system of spheres, Pole, Polar and Conjugacy.

Locus, Surfaces, Curves and Conicoids: Space curves, some standard surfaces, Classification of quadric surfaces, Cone, Cylinder, Central conicoids, Tangent plane, Normal, Polar planes and Polar lines, paraboloid.

Text Book:

1. S. L. Loney (1994). The elements of Coordinate Geometry. Macmillan India Ltd.

Reference Books:

1. Robert J.T. Bell (1994). An Elementary Treatise on Coordinate Geometry of Three Dimensions. Macmillan India Ltd.
2. D. Chatterjee (2009). Analytical Geometry: Two and Three Dimensions. Narosa Publishing House.

Course Outcomes: This course will enable the students to -

1) To learn about fundamental idea of geometrical concepts.
2) Understand the importance graphical figures by geometry.
3) Familiarize with geometrical figures.
4) Apply problem-solving with differential geometry to diverse situations in physics,engineering and in other mathematical contexts.

5) Explain the properties of three-dimensional shapes.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3		1	2								3		2
CO2	3	2		3	2								3		2
CO3	3	2		2	2								3		2
CO4	3	3		3	2								3		2
CO5	3	3		3	2								3		2

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUBTG1	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code: AMUBTG1

ALGEBRA AND MATRIX THEORY

Course Objective: The course should enable the students -

1) To learn about concept of set theory, relation and function.
2) Characterize a matrix using the concepts of rank, column space, and null space.
3) Apply the formal definition of an inverse, and its algebraic properties, to solve and analyze linear systems.
4) To learn the concept of group theory.
5) Demonstrate familiarity with Ring and Field.

Sets, Relations, Function or mapping, injective and subjective mappings, Images and inverse images of a set under a mapping, Equivalence relation and partition, partial order relation and Zorn's lemma (without proof), Binary operations.

Group: Definition, examples, property. Subgroup, Union and intersection of groups, cyclic group, order of the group, Group of symmetries and examples, Permutation group.

Ring: Definition and examples, property, Subring, Ideal, Integral Domain.
Field: Definition and, example

Matrix algebra: Introduction, Elementary operations of matrices. Inverse of a matrix. Rank of a matrix, Echlon form of a matix, Normal Form, Application of matrices to the system of linear equations, Consistency of the system of linear equations.

Books Recommended:

1. Titu Andreescu and Dorin Andrica, *Complex Numbers from A to Z,* Birkhäuser, 2006.
2. David C. Lay, *Linear Algebra and its Applications,* 3rd Ed., Pearson
3. P.R. Bhattacharya, S.K. Jain and S.R.Nagapaul Basic Abstract Algebra IInd Edition cambridge University press Indian Edition 1997.
4. I.N.Herstein Topics in Algebra, Wiley Eastern Ltd. New Delhi 1975.

Course Outcomes: This course will enable the students to -

1) Understand basic concept of set, relation and functions.
2) Analyze the concepts of various types of groups.
3) Learn the basic of Ring theory.
4) Study the fields and related concepts.
5) Understand different types of matrix theory.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1									3		
CO2	3	2	2	3									3		
CO3	3	2	2	2									3		3
CO4	3	3	2	3									3		
CO5	3	3	1	3									3		

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUBTG2	4	1	0	5 HOURS	30	70	5

Paper Code: AMUBTG2
To be prepared Later

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUCTG1	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code: AMUCTG1

DIFFERENTIAL CALCULUS

Course Objectives: This course will enable the students to –

1) The goal of this course is for students to gain proficiency in calculus computations.
2) To learn three main tools for analyzing and describing the behavior of functions limits, derivatives and integral.
3) To demonstration Series solution, Rolle's theorems and Mean value theorems, etc.
4) To lean deep knowledge geometrical interpretations.
5) To understand the tools to solve application problems in a variety of setting ranging from physics and biology to business and economics etc.

Limit and Continuity: (ε, δ) definition, Types of discontinuities, Differentiability of functions, n^{th} Derivative, Successive differentiation, Leibniz rule and its applications.

Tangents and normals, Curvature, Asymptotes, Singular points, Tracing of curves. Parametric representation of curves and tracing of parametric curves. Polar coordinates and tracing of curves in polar coordinates.

Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of sin x, cosx, e^x, log(l + x), $(l + x)^m$, Maxima and Minima, Indeterminate forms.

Functions of Two Variables: Limit, Continuity, Differentiability. Partial differentiation, Change of variables, Euler's and Taylor's theorem. Maxima and minima. Double and triple integrals, Change of order in double integrals. Beta and Gamma functions.

Text Books:

1. Shanti Narayan, A Text Book of Vector Calculus, S. Chand & Company, New Delhi.
2. S. C. Mallik, Mathematical Analysis, Wiley Eastern Ltd, New Delhi.

Reference Books:

1. Gabriel Klaumber, Mathematical Analysis, Marcel Dekkar, New York 1975.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 1999.
3. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2002.
4. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2007.

Course Outcomes: This course will enable the students to –

1) Assimilate the notions of limit of a sequence and convergence of a series of realnumbers.
2) Calculate the limit and examine the continuity of a function at a point.
3) Understand the consequences of various mean value theorems for differentiablefunctions.
4) Sketch curves in Cartesian and polar coordinate systems.
5) Apply derivative tests in optimization problems appearing in social sciences, physicalsciences, life sciences and a host of other disciplines.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	2											3		
CO2	2	2											3		
CO3	2	2											3		
CO4	2	2											3		
CO5	2	2											3		

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUCTG2	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code: AMUCTG2

HISTORY OF INDIAN MATHEMATICS

Course Objectives: This course will enable the students to –

1) The core objective of this course is related to understand Indian knowledge system specially area of mathematics and mathematical thoughts.
2) The foremost important objective of introducing this paper into learns about the work of the great Indian mathematicians.
3) It is important to understand development of mathematics is a branch of Indian traditional knowledge. The objective of doing so is supposed concepts in one of the oldest surviving India culture and society.
4) The course is aimed to let a student understand Indian traditional knowledge in geometry, common astronomy, infinite series and calculus.
5) This course is also having an objective to tend a student how mathematical thoughts and concepts have migrated from one culture to another and how Indian knowledge system has continued in development of modern mathematics.

History of Origin of Mathematics, The Number Symbols Arithmetic Operations, Ancient and Early Medieval Indian Mathematics, Early Hindu Mathematics, Hindu Arithmetic and Algebra, Hindu Geometry and Trigonometry, History of Mathematics in South Asia.

About Mathematics in Vedas, The *Sulba-Sutras*, The Vedas and Astronomy, The Jyotisa-Vedanga, Vedic India and Ancient Mesopotamia. Mathematics in Ancient, Early Medieval and Medieval India.

Numbers and Numerals, Astronomy, Astrology and Cosmology, Mathematics in Jain and Buddhist texts.

Geocentric Astronomy, Evolution of the Siddhanta and Astronomical Schools, Astronomical Calculations in Siddhantas, Geometric modes in Astronomy
Medieveal Mathematics:- Mathematics in Siddhanatas, Bakhshah Manuscript, Ganita-Sara-Sangraha.

The Development of “Canonical” Mathematics: - Mathematician and Society, About work Bhaskara & Narayana Pandita, Mathematical writing and thought.

The School of Madhava in Kerla: - Background, Lineage, Infinite Series and other Mathematics, Astronomy and Scientific Methodology, Questions of Transmission.

Exchanges with the Islamic World:- Indian Mathematics in the word, Mathematical Encounters in India, Influence and Synthesis.

Continuity and Changes in the Modern period:-Individuals, Families and Schools, Contacts with Europe, Mathematics and Astronomy, 1500-1800

Recommended Text Books:

1. Mathematics in India by Kim Plofker

Suggested Readings:

2. Mathematical Thought from Ancient to Modern Times volume-1 by Morris Kline
3. Culture and History of Mathematics Edited Volume editor C.S.Seshadri
4. वेदों में विज्ञान लेखक डॉ कपिलदेव.द्विवेदी

Course Outcomes: - After completing this course student is supposed to -

1. Learn about the history of contribution of Indian mathematics from Vedic era to medieval period.
2. Learn about the role of perception, inference, analogy and authoritative testimony in Indian mathematics.
3. Understand substantial differences between mathematics in the India tradition and its counter parts.
4. Multiply the interest by manifold in the traditional Indian mathematical development from numbers to Calculus, Infinite series, Geometry and Astronomy.
5. Understand the rich scientific and cultural heritage of India.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1		1	2	2		2	2	3	1	1		2	2	1	2
CO2	3	2	2	2		1	2	2	1	1	1	2	1	1	1
CO3	1	1	1	1			1	1	1	1	1	2			
CO4	2	2	2	2				2	2	2	2	2	3	1	3
CO5	1	2	2	1		1			1	1		1	1		1

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUDTG1	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code: AMUDTG1

APPLICATIONS OF ALGEBRA

Course Objectives: The objective of this course is –

1) To learn about the concepts of Balanced incomplete block designs (BIBD).
2) To learn about basic concepts of coding theory.
3) To discuss various properties of symmetric groups.
4) To give idea about Special types of matrices.
5) To discuss few other Applications of linear transformations.

Balanced incomplete block designs (BIBD): definitions and results, incidence matrix of a BIBD, construction of BIBD from difference sets, construction of BIBD using quadratic residues, difference set families, construction of BIBD from finite fields.

Coding Theory: introduction to error correcting codes, linear cods, generator and parity check matrices, minimum distance, Hamming Codes, decoding and cyclic codes.

Symmetry groups and color patterns: review of permutation groups, groups of symmetry and action of a group on a set; colouring and colouring patterns, Polya theorem and pattern inventory, generating functions for non-isomorphic graphs.

Special types of matrices: idempotent, nilpotent, involution, and projection tri diagonal matrices, circulant matrices, Vandermonde matrices, Hadamard matrices, permutation and doubly stochastic matrices, Frobenius- König theorem, Birkhoff theorem. Positive Semi-definite matrices: positive semi-definite matrices, square root of apositive semi- definite matrix, a pair of positive semi-definite matrices, and their simultaneous diagonalization. Symmetric matrices and quadratic forms: diagonalization of symmetric matrices, quadratic forms, constrained optimization, singular value decomposition, and applications to image processing and statistics.

Applications of linear transformations: Fibonacci numbers, incidence models, and differential equations. Least squares methods: Approximate solutions of system of linear equations, approximate inverse of an $m\times n$ matrix, solving a matrix equation using its normal equation, finding functions that approximate data. Linear algorithms: LDU factorization, the row reduction algorithm and its inverse, backward and forward substitution, approximate inverse and projection algorithms.

Books Recommended:

1. I. N. Herstein and D. J. Winter, *Primer on Linear Algebra*, Macmillan Publishing Company, New York, 1990.
2. S. R. Nagpaul and S. K. Jain, *Topics in Applied Abstract Algebra*, Thomson Brooks and Cole, Belmont, 2005.
3. Richard E. Klima, Neil Sigmon, Ernest Stitzinger, *Applications of Abstract Algebra with Maple*, CRC Press LLC, Boca Raton, 2000.
4. David C. Lay, *Linear Algebra and its Applications.* 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
5. Fuzhen Zhang, *Matrix theory*, Springer-Verlag New York, Inc., New York, 1999.

Course Outcomes: After completions of this course, students will be able -

1) To understand the concepts of Balanced incomplete block designs (BIBD).
2) To understand basic concepts of coding theory.
3) To understand symmetric groups with different orders with examples.
4) To understand idea about Special types of matrices and their properties.
5) To solve various kind of applications of linear transformations.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3		2								3	2	1
CO2	3	2	3	1	2								3	2	1
CO3	3	2	3	1	2								3	2	1
CO4	3	2	3	1	2								3	2	1
CO5	3	2	3	1	2								3	2	1

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUDTG2	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code: AMUDTG2

COMBINATORIAL MATHEMATICS

Course Objectives: In this course, students will become familiar with -

1) Fundamental combinatorial structures that naturally appear in various other fields of mathematics and computer science.
2) They will learn how to use these structures to represent mathematical and applied questions, and they will become comfortable with the combinatorial tools commonly used to analyze such structures.
3) Given a hypothetical combinatorial object that must satisfy certain properties, students will learn how to prove the existence or non-existence of the object, compute the number of such objects and understand their underlying structure.
4) Describe solutions to iterated processes by relating recurrences to induction, generating functions, or combinatorial identities.
5) Analyze a counting problem by proving an exact or approximate enumeration, or a method to compute one efficiently.

UNIT-1:
Basic counting principles, Permutations and Combinations (with and without repetitions), Binomial theorem, Multinomial theorem, Counting subsets, Set-partitions, Stirling numbers.

UNIT-2:
Principle of Inclusion and Exclusion, Derangements, Inversion formulae.
Generating functions: Algebra of formal power series, Generating function models, calculating generating functions, Exponential generating functions.

UNIT-3:
Recurrence relations: Recurrence relation models Divide and conquer relations, Solution of recurrence relations, Solutions by generating functions. Integer partitions, Systems of distinct representatives.

UNIT-4:
Polya theory of counting: Necklace problem and Burnside's lemma, Cyclic index of a permutation group, Polya's theorems and their immediate applications.

UNIT-5:
Latin squares, Hadamard matrices, combinatorial designs: *t* designs, BIBDs, Symmetric designs.

Books Recommended:

1. J.H. van Lint and R.M. Wilson, *A Course in Combinatorics*, 2nd Ed., Cambridge University Press, 2001.
2. V. Krishnamurthy, *Combinatorics, Theory and Application*, Affiliated East-West Press 1985.
3. P.J. Cameron, *Combinatorics*, *Topics*, *Techniques*, *Algorithms*, Cambridge University Press, 1995.
4. M. Jr. Hall, *Combinatorial Theory*, 2nd Ed., John Wiley & Sons, 1986.
5. S.S. Sane, *Combinatorial Techniques*, Hindustan Book Agency, 2013.
6. R.A. Brualdi, *Introductory Combinatorics*, 5th Ed., Pearson Education Inc., 2009.

Course Outcomes: After successful completion of this paper the students will be able to -

1) Students will be able to utilize mathematics and computer applications to solve practical problems in mathematics.
2) This course will give students the combinatorial tools to model and analyze practical problems in various areas.
3) Students will be able to identify, formulate and solve problems in mathematics, including proof writing. The course will teach students how to understand and deal with enumerative problems.
4) They will put to practice problem solving techniques that they know and learn new ones, such as non-constructive existence proofs and the probabilistic method.
5) Students will be able to present technical information clearly in both oral and written formats.

Course Outcomes and their mapping with Programme Outcomes:

CO	**PO**												PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	1	1	1					1		1	1		1
CO2	2	2	2	1		1					1	1	2	1	1
CO3	2	2	1	2	1					2	1	1	2	2	2
CO4	2	2	1	2	1	1				1	1	2	1	2	2
CO5	2	2	1	1	2	1				1	2	2	2	1	1

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUDTG3	**4**	**1**	**0**	**5 HOURS**	**30**	**70**	**5**

Paper Code-AMUDTG3

THEORY OF EQUATIONS

Course Objective: The course should enable the students -

1) To learn about fundamental idea of solving algebraic equations.
2) To study the properties of equations and relations between roots and coefficients.
3) To study the symmetric functions and its applications.
4) To study the binomial, cubic, reciprocal and biquadratic equations.
5) To study the Sturm theorem, Newton's theorem and its applications.

General Properties of polynomials, graphical representation of a polynomial, maximum and minimum values of a polynomial, general properties of equations, Descarte's rule of signs positive and negative rule, relation between the roots and the coefficients of equations.

Symmetric functions, applications of symmetric function of the roots, transformation of equations, solutions of reciprocal and binomial equations, algebraic solutions of cubic and biquadratic, properties of the derived functions.

Symmetric functions of the roots, Newton's theorem on the sums of powers of roots, homogeneous products, limits of the roots of equations.

Separation of the roots of equations, Sturm theorem, application of Sturm's theorem, and sufficient condition for existence of real roots an equation and biquadratic equation.

Course Learning Outcomes: This course will enable the students to find the roots of general algebraic equations

Text Book:

1. C. C. Mac-Duffee (1954). Theory of Equations, John Wiley & Sons Inc.

Reference Books:

1. W. S. Burnside and A. W. Panton (1954). The Theory of Equations, Dublin University Press.
2. D. Chatterjee (2009). Analytical Geometry: Two and Three Dimensions. Narosa Publishing House.

Course Outcomes: On completion of the course, a student will be able to -

1) Find the roots of general algebraic equations.

2) Describe the graphical representation of a polynomial, maximum and minimum values of a polynomial.
3) Acquire the concept of symmetric functions.
4) Use Newton's theorem to find the sums of power of roots, homogeneous products, limits of the roots of equations.
5) Derive Sturm's theorem and its application.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2											2
CO2	1	1	1	2											2
CO3	1	1	1	1											2
CO4	1	1	1	1											2
CO5	2	1	1	1											2

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

ABILITY ENHANCEMENT COURSE (AEC)

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUATA1	2	0	0	2 HOURS	30	70	2

Paper Code: AMUATA1

SET THEORY AND LOGIC

Course Objective: The course should enable the students -

1) Describe memberships of sets, including the empty set, using proper notation, and decide whether given items are members and determine the cardinality of a given set.
2) Recognize when set theory is applicable to real-life situations, solve real-life problems, and communicate real-life problems and solutions to others.
3) Understand basic concept of logic and analyze the concepts of truthiness.
4) Working of different types of logic.
5) Understand different types of theory and Explore and apply key concepts in logical.

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

Difference and Symmetric difference of two sets. Set identities, generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations, and n-ary relations.

Books Recommended:

1. R.P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson Education, 1998.
2. P.R. Halmos, *Naive Set Theory*, Springer, 1974.
3. E. Kamke, *Theory of Sets*, Dover Publishers, 1950.

Course Outcomes: This course will enable the students to -

1) Understand basic concept of logic.
2) Analyze the concepts of truth ness.
3) Study of different types of sets.
4) Learn about relations.
5) Theoretical concepts of mathematics.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3											3		
CO2	3	2	2	3									3		
CO3	3	2		2									3		
CO4	3	3		3									3		
CO5	3	3	2	3									3		

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUATA2	**2**	**0**	**0**	**2 HOURS**	**30**	**70**	**2**

Paper Code: AMUATA2

BASICS OF STATISTICS

Course Objective: This course will enable the students to -

1) Explain the basic ideas of measures of central tendency, dispersion and their applications.
2) Adapt the knowledge of various Probability distributions and their applications.
3) Apply statistical techniques for sampling of big data.
4) Explain a formulation helping to predict one variable in terms of the other that is, correlation and linear regression.
5) Translate real-world problems into probability models.

Unit-1: Review on Probability
Measures of Central Tendency, Measures of Dispersion, Probability, Conditional Probability, Random Variables, Expected Value, Moment generating function, Probability Distributions, Binomial Distribution, Poission Distribution, Normal Distribution.

Unit-2: Sampling Methods
Random Sampling and Methods of Samplings, Sampling distribution and standard error, Sampling distribution of the Sample Mean, Central limit theorem, Sampling distribution of the sample proportion, Sampling distribution of the difference between two sample means and Sampling distribution of the difference between two sample proportions.

Unit-3: Correlation and Regression
Correlation Karl Pearson's Coefficient of correlation, Rank correlation, linear regression, Lines of regression, Inferences concerning the regression coefficients.

References:

1. S. C. Gupta and V. Kapoor, Fundamentals of mathematical Stastics, Sultanchand and Son's, New Delhi.
2. Robert V. Hogg, Joseph W. McKean & Allen T. Craig(2013), Introduction to Mathematical Statistics(7th Edition), Person Education.
3. Irwin Miller &Marylees Miller (2014). *John E. Freund's Mathematical Statistics with Applications* (8thedition). Pearson. Dorling Kindersley Pvt. Ltd. India.JimPitman (1993). *Probability*,Springer-Verlag.
4. Sheldon M. Ross (2014). *Introduction to Probability 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.

Course Objectives: Upon successful completion of this course, students will be able to -

1) Use the basic probability rules, including additive and multiplicative laws, using the terms, independent and mutually exclusive events.
2) Identify the type of statistical situation to which different probability distributions can be applied.
3) Use discrete and continuous probability distributions to solve statistical problems and make decisions.
4) Calculate and interpret the correlation between two variables and employee the principles of linear regression and correlation, predicting a particular value of Y for a given value of X and significance of the correlation coefficient.
5) Use sampling techniques and draw valid conclusion.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	2	1	3	3	1		2	3	3	3	2		
CO2	3	2	2	3		2	1		1	1	2	3	2		
CO3	3	3	2	2	3	3	3		3	3	3	3	2		
CO4	3	3	3	3	3	3	3		3	3	3	3	2		
CO5	3	3	3	3	3	3	3		3	3	3	3	2		

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUBTA1	**2**	**0**	**0**	**2 HOURS**	**30**	**70**	**2**

Paper Code: AMUBTA1

THEORY OF INTERPOLATION

Course Objective: This course will enable the students to –

1) To Understand Accuracy and precision with examples.
2) Adequate exposure to learn alternative methods and analyze mathematical problems to determine the suitable numerical techniques.
3) Use the concepts of interpolation, eigen value problem techniques for mathematical problems arising in various fields
4) Solve initial value and boundary value problems which have great significance in engineering practice using ordinary and partial differential equations.
5) Demonstrate elementary programming language, implementation of algorithms and computer programs to solve mathematical problems.

Finite Difference: Forward difference, backward difference, central difference, difference of polynomial, other difference operator etc.

Interpolation: Introduction, Newton's forward interpolation formula, Newton's backward interpolation formula, Central difference interpolation formula, Gauss's forward and backward interpolation formula, Sterling's and Bessel's formulae.

Interpolation with unequal intervals: Lagrange's interpolation formula, divided difference, Newton's divided difference formula.

Text Books:

1. Jain M K, Iyengar S R K and Jain R K, Numerical Methods for Scientific and Engineering Computation, 4th Edn, New Age International Pvt. Ltd (2005)
2. S S Sastry, Introductory Methods of Numerical Analysis, 5th Edn. Prentice Hall of India.

Reference book:

1. Jain M K, Numerical Solutions of Differential Equations, 2nd Edn, John Wiley and Sons Ltd (1984)

Course Outcomes: At the end of the course student will

1) Acquire basic knowledge in solving interpolation with equal interval problems by various numerical methods. Estimate the missing terms through interpolation methods.

2) Develop skills in analyzing the methods of interpolating a given data, properties of interpolation with unequal intervals and derive conclusions, approximate a function using an appropriate numerical method.
3) Use relevant numerical techniques for interpolation with equal and unequal intervals..
4) Examine the appropriate numerical differentiation and integration methods to solve problems.
5) Apply the numerical methods to solve algebraic as well as differential equations.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2	3	3	1		2	3	3	3	2	2	
CO2	2	3	2	2	3	3	1		2	3	3	3	2	2	
CO3	2	3	2	2	3	3	1		2	3	3	3	2	2	

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUBTA2	2	0	0	2 HOURS	30	70	2

Paper Code: AMUBTA2
To be prepared later

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUCTA1	**2**	**0**	**0**	**2 HOURS**	**30**	**70**	**2**

Paper Code-AMUCTA1

CURVE TRACING

Course Objectives: This course will enable the students to –

1) To learn about basics of tracing complicated curve.
2) Tracing of conics in Cartesian coordinates/ polar coordinates.
3) Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, and hyperbolic paraboloid using Cartesian coordinates
4) Explain how the sign of the first derivative affects the shape of a function's graph
5) Apply the concepts of asymptotes, and inflexion points in tracing of Cartesian curves.

Introduction, curves in Cartesian form, general procedure for tracing the algebraic curve-symmetry, region, Asymptotes, origin, tangents to the curve at the origin, intercepts, sign of first and second derivative, nature of curve, maxima and minima, inflection point, multiple point or singular point, curve tracing of standard curves in Cartesian form, folium of Descartes, Cissoid, lemniscate of Bernoulli, Strophoidetc, tracing of curves in polar and parametric curves.

Text Books:

1. Gorakh Prasad (2009), Differential Calculus, Pothishala Private Limited, Allahabad.
2. B. V. Ramana (2017), Higher Engineering Mathematics, McGraw Hill Education.

Reference Books:

1. E. H. Lockwood (1961), A book of Curves, Cambridge University Press.
2. W. W. Johnson (2010), Curve Tracing in Cartesian Coordinates, Coss Press.

Course Outcomes: After the completion of the course student will be able to -

1) Draw the diagram of standard as well as little bit complicated curve which may occur in their problem of studies.
2) Trace standard curves in Cartesian coordinates and polar coordinates.
3) Sketch parametric curves (Ex. trochoid, cycloid, epicycloids, hypocycloid).
4) Apply the knowledge of curve tracing and geometry to precisely estimate areas and volumes.
5) Trace standard curves in Cartesian coordinates and polar coordinates.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	1	1	1	1	1	1	1	2	1	1	1

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUCTA2	2	0	0	2 HOURS	30	70	2

Code-AMUCTA2
To be prepared later

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUDTA1	2	0	0	2 HOURS	30	70	2

Paper Code-AMUDTA1

MATRIX AND DETERMINANT

Course Objectives: This course will enable the students to –

1) Construct, or give examples of, mathematical expressions that involve vectors, matrices, and linear systems of linear equations.
2) Apply the row reduction algorithm to compute the coefficients of a polynomial.
3) Apply theorems to compute determinants of matrices that have particular structures.
4) Apply properties of determinants (related to row reductions, transpose, and matrix products) to compute determinants.
5) Express linear systems as vector equations and matrix equations.

Elementary transformation of a matrix, Rank of a matrix- normal form and Echelon form, inverse of matrix-Gauss-Jordan Method and Partition method, consistency of system of linear equations, solution of linear system of equations-Cramer's Rule, Gaussian Elimination Method and matrix inversion method, orthogonal matrix, eigen values and eigen vectors of a matrix, Cayley-Hamilton theorem (without proof), diagonalization of a matrix (without proof).

Text Books:

1. Kenneth Hoffman & Ray Kunze (2015), Linear Algebra (2^{nd} edition), Prentice Hall India Learning Private Limited.
2. B. V. Ramana (2017), Higher Engineering Mathematics, McGraw Hill Education.

Reference Books:

1. Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2003), Linear Algebra (4rth edition), Prentice-Hall of India Pvt. Ltd.
2. Nathan Jacobson (2009), Basic Algebra I (2^{nd}edition), Dover Publications.

Course Outcomes: This course will enable the students to -

1) Understand basic concept of set, relation and functions.
2) Analyze the concepts of various types of groups.
3) Learn the basic of Ring theory.
4) Study the fields and related concepts.
5) Understand different types of matrix theory.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1									3		
CO2	3	2	2	3									3		
CO3	3	2	2	2									3		3
CO4	3	3	2	3									3		
CO5	3	3	1	3									3		

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUDTA2	2	0	0	2 HOURS	30	70	2

Code-AMUDTA2:
To be prepared later

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUETA1	**2**	**0**	**0**	**2 HOURS**	**30**	**70**	**2**

Paper Code-AMUETA1

INTEGRAL TRANSFORM

Course Objective: This course will enable the students to –

1) To understand of the students of basics Laplace Transform with properties and problems.
2) To learn application of the Laplace Transform in obtaining solutions of ordinary differential equations and integral equations.
3) To learn of basics Fourier transform with properties and problems.
4) To understand solution of integral equations by Fourier transform.
5) To understand basics Fourier series and differentiation and integration of Fourier series.

Laplace Transforms: Laplace and inverse Laplace transforms, linearity property, existence theorem, Laplace and inverse Laplace transforms of derivatives and integrals, shifting theorems, translations theorems, change of scale property, Laplace transforms of periodic functions Dirac's delta function, application of Laplace transform.

Fourier Transforms: Fourier and inverse Fourier transforms, Fourier Sine and Cosine transforms, inverse Fourier Sine and Cosine transform, linearity property, change of scale property, shifting property, modulation theorem, Relation between Fourier and Laplace transforms, application of Fourier sine and cosine transforms.

Text Books:

1. Erwin Kreyszig (2011), Advanced Engineering Mathematics (10th edition). Wiley Publication.
2. B. V. Ramana (2017), Higher Engineering Mathematic, McGraw Hill Education.

Reference Books:

1. James Ward Brown & Ruel V. Churchill (2011), Fourier Series and Boundary Value Problems. McGraw-Hill Education.
2. J. K. Goyal & K. P. Gupta (2016), Laplace and Fourier Transforms, Pragati Prakashan.

Course Learning Outcomes: This course will enable the students to –

1) Know about piecewise continuous functions, Dirac delta function, Laplace transforms and its properties.

2) Solve ordinary differential equations using Laplace transforms
3) Familiarise with Fourier transforms of functions belonging to $L^1(\mathbb{R})$ class, relation between Laplace and Fourier transforms.
4) Explain applications of Fourier transforms to boundary value problems and apply the concepts of the course in real life problems.
5) Learn Fourier series, term by term differentiation and integration of Fourier series.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	2											1		
CO2	2	2											1		
CO3															
CO4															
CO5															

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUETA2	**2**	**0**	**0**	**2 HOURS**	**30**	**70**	**2**

Code-AMUETA2:
To be prepared later

SKILL ENHANCEMENT COURSE (SEC)

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUATL1	2	0	0	2 HOURS	30	70	2

Paper Code: AMUATL1

INTRODUCTION TO CRYPTOGRAPHY

Course Objectives: - This course aims to -

1) Introduce students to the basic concepts and techniques used in cryptography, including encryption, decryption, key management, and digital signatures. This includes an overview of classic and modern cryptographic algorithms and their properties.
2) To learn about how to maintain the Confidentiality, Integrity and Availability of a data.
3) Teach students how to analyze cryptographic protocols for their security and privacy properties. This includes topics such as formal verification, threat modeling, and security testing.
4) Teach students how to implement cryptographic algorithms using programming languages. This includes topics such as key generation, encryption, decryption, and digital signatures.
5) Provide students with an understanding of the challenges and issues faced by real-world cryptographic systems, such as side-channel attacks, timing attacks, and implementation flaws.

Basic Concept of Cryptography, Information security, Background on functions, Basic terminology and concepts, Symmetric-key encryption, Digital signatures, Authentication and identification, Public-key cryptography, Hash functions, Protocols and mechanisms, Key establishment, management and certification, Pseudorandom numbers and sequences, Classes of attacks and security models, Identification and Entity Authentication, Digital Signatures, Efficient Implementation, Patents and Standards. Basic concepts of elliptic curve and quantum cryptography.

Text Books:

1. Wenbo Mao, Modern Cryptography: Theory and Practice. Pearson Education, 2004
2. J Buchmann, Introduction to Cryptography, Springer (India) 2004
3. A. Menezes, P. van Oorschot and S. Vanstone, Handbook of Applied Cryptography, CRC Press

Course Outcomes: This course will enable the students to -

1) Develop the skills necessary to implement cryptographic algorithms, including the generation of keys, encryption, decryption, and digital signatures.
2) Gain knowledge of modern cryptographic algorithms, including symmetric-key and public-key cryptography, as well as their strengths and weaknesses.
3) Understand the importance of key management, including the distribution, storage, and revocation of cryptographic keys.
4) Develop critical thinking and problem-solving skills through practical exercises and assignments that require the application of cryptographic concepts and techniques.
5) Develop effective communication skills through written and oral presentations of technical material related to cryptography.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	1	1						1	2	2	1

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUATL2	2	0	0	2 HOURS	30	70	2

Paper Code: AMUATL2

SPECIAL FUNCTION

Course Objective: This course aims to -

1) Understand the properties of special functions like Gamma, Legendre functions with their integral representations.
2) Understand the concept of Bessel's function with its properties like recurrence relations, orthogonal properties, generating functions etc.
3) Understand how special function is useful in differential equations.
4) To determine properties of Legendre Polynomial this may be solved by application of special functions.
5) To analyze properties of special functions by their integral representations and symmetries.

Gamma function, Standard results for Gamma function, Beta function, Standard results for Beta function,

Bessel's function, Generating function, Orthogonality of Bessel's function, Recurrence relations for Bessel's function, Elementary Bessel's function, Legendre polynomial, Rodrigues's formula, Generating function Legendre polynomial, Orthogonality of Legendre polynomials.

Text Book:

1. B. V. Ramana (2007). *Higher Engineering Mathematics,* McGraw Hill Education (India) Pvt. Ltd.

Reference Book:

1. Z. X. Wang, D. R. Guo, Zhi Xu Wang (1989), Special Functions, World Scientific Publishing Company

Course Outcomes: After completion of this course, student will be able to –

1) Understand the infinite product and properties of Beta and Gamma functions.
2) Analyze the properties generating functions.
3) Perform operations with Bessel and Legendre differential equations along with the corresponding recurrence formulas of different functions.
4) Demonstrate their understanding of how physical phenomena are modeled using special functions.
5) Explain the applications and the usefulness of special functions.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	1	1				1		1	1	1	2	1	2
CO2	2	2	1	1		2		1		1	1	2	1	1	1
CO3															
CO4															
CO5															

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUBTL1	**2**	**0**	**0**	**2 HOURS**	**30**	**70**	**2**

Paper Code: AMUBTL1

GRAPH THEORY

Course Objectives: The main concern of Graph Theory is to -

1) Improve the proof writing skills.
2) Understand the basics of graph theory and their various properties.
3) Model problems using graphs and to solve these problems algorithmically.
4) Apply graph theory concepts to solve real world applications like routing, TSP/traffic control, etc.
5) Optimize the solutions to real problems like transport problems etc.,

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Books Recommended

1. B.A. Davey and H.A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge, 1990.
2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory*, 2nd Edition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
3. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

Course Outcomes: After successful completion of this paper the students will be able to:

1) Appreciate the definition and basics of graphs along with types and their examples.
2) Understand the definition of a tree and learn its applications to fundamental circuits.
3) Analyze the significance of graph theory in different engineering disciplines
4) Demonstrate algorithms used in interdisciplinary engineering domains.
5) Evaluate or synthesize any real world applications using graph theory.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	3	1						1	1	1	2	1

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	IA	ESE	CREDITS
AMUBTL2	2	0	0	2 HOURS	30	70	2

Paper Code: AMUBTL2

LINEAR PROGRAMMING

Course Objective: This course will enable the students to –

1) To understand basic terminology &basic concepts related to linear programming problems (LPP) of real life situations.
2) To understand the few initials method for the solutions of linear programming problems.
3) To get familiarize with the mathematical formulation of a real world problem.
4) To acquaint with the problem solving techniques theoretically as well as graphically.
5) To tackle several parameters into account while dealing with the problem and to make aware the students about the applications of various forms of Linear Programming.

Unit-I: Linear Programming Problem, **Convexity and Basic Feasible Solutions**
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, Big-*M* method.

Text Book:

1. Hamdy A. Taha (2017).Operations Research: An Introduction (10thedition).Pearson.

Reference Books:

2. Mokhtar S. Bazaraa, John J. Jarvis& Hanif D. Sherali (2010). Linear Programming and Network Flows (4thedition). John Wiley & Sons.
3. G. Hadley (2002). Linear Programming .Narosa Publishing House.

Course Outcome: Students will try to learn -

1) Basic understanding & terminology related to linear programming problems (LPP) of real life situations.
2) Some initials method for the solutions of linear programming problems, game problems.
3) Distinguish use of different methods to various kinds of LPP on the basis of type of

constraints and number of variable.

4) Judge Importance of solution obtained in terms of uniqueness, bound and optimality
5) Formulate mathematical model for management and technical problems using LPP concepts.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	2	2						2	3	3	2	1
CO2	2	3	3	3	3						3	3	3	2	1
CO3															
CO4															
CO5															

Weightage: 1-Sightly; 2-Moderately; 3-Strongly

SUB CODE	L	T	P	DURATION/WEEK	Total Marks	CREDITS
AMUFST1	**2**	**0**	**0**	**2 HOURS**	**100**	**2**

Paper Code: AMUFST1

SEMINAR

SUB CODE	L	T	P	DURATION/WEEK	Total Marks	CREDITS
AMUFDT1	**7**	**0**	**0**	**7 HOURS**	**100**	**7**

Paper Code: AMUFDT1

DISSERTATION/PROJECT