COURSE OUTCOMES

MATHEMATICS DEPARTMENT

	FYBSC.
	Sem I
	Paper I CALCULUS – I Course Code: USMT 101
CO I	Describe the real line as a complete, ordered field, Determine the basic topological properties of subsets of the real numbers and produce rigorous proofs of results that arise in the context of real analysis.
CO II	To understand the concept of Intervals and neighborhoods, interior points, Bounded sets, supremum and infimum. To understand use of inequalities, Hausdorff property, I.u.b. axiom and its consequences, Archimedean property and its applications, density of rationals.
CO III	Use the definitions of convergence as they apply to sequences, series, and functions. To understand Limit of a convergent sequence and uniqueness of limit. To study Convergence of some standard sequences
CO IV	To analyze the boundedness and monotonic behavior of sequences. To understand algebra of convergent sequences and properties of subsequences.
CO V	To understand graphs of some standard functions. To study the existence of limit and continuity of a function.
	Paper II ALGEBRA – I I Course Code: USMT 102
CO I	To understand the process of induction, binomial theorem and Pascal triangle and ability to apply them in solving problems involving binomials. To solve problems by using divisibility of integers and fundamental theorem of arithmetic. To understand the concept of congruence and some standard theorems.
CO II	To understand the concept of function, domain, co-domain and range of a function, image, inverse image, injective, surjective, bijective functions, Composite of functions, invertible functions. To study examples of functions including constant, identity, projection, inclusion.
CO III	To understand binary operation as a function, it's properties and examples. To understand the concept of Equivalence relation, Equivalence classes and its properties. To understand the construction of Congruence and modulo n, Multiplication modulo n, examples.
CO IV	To understand the concept of polynomial and its basic properties. To use Divisional Algorithm to find quotient and remainder when two polynomials are divided and its applications and Euclids algorithm for finding GCD of polynomial.
CO V	To analyze the roots of polynomials and their properties.
	SEM - II
	Paper I CALCULUS - II Course Code: USMT 201
CO I	To understand the Calculations of limit of series and use of Convergence tests. To understand the properties of continuous and differentiable functions.
CO II	To determine the continuity, differentiability of functions defined on subsets of the real line, Apply the Mean Value Theorem and the Fundamental Theorem of Calculus to problems in the context of real analysis
CO III	To understand the concept of Extreme values, increasing and decreasing functions.
CO IV	To solve problems on Taylors theorem and Taylors polynomials

	Paper II ALGEBRA – II Course Code: USMT 202
CO I	Students will be able to set up and solve linear systems graphically / geometrically and algebraically (using matrices). Represent vectors analytically and geometrically, and presentations of lines and planes. To solve system of equations by matrices.
CO II	To analyze vectors geometrically and algebraically, Recognize the concepts of the terms span, linear independence, basis, and dimension.
CO III	Apply concepts to various vector spaces and subspaces, Use matrix algebra and the related matrices to linear transformations.
CO IV	To understand the concept of Linear Transformation, Kernel, Image of a linear map ,Verifying Rank Nullity Theorem.
	S.Y.B.Sc.
	Sem III
	Paper I CALCULUS – III Course code – USMT 301
CO I	Using the Euclidean inner product and Euclidean norm function in $\mathbb{R}^n$, a student can find distance between two points, using the definition of an open ball, open set he can determine whether the given set is an open set, define scalar and vector valued functions, explain the basic results on limits and continuity of such functions and solve examples, evaluate partial and directional derivative of a given function.
CO II	Can distinguish between scalar and vector valued functions and explain the basic results on limits and continuity of such functions, evaluate partial and directional derivative of a given function.
CO III	He can use definition of differentiability on many variables to find total derivative, gradient, partial derivatives, explain the relationship between them, evaluate higher order derivative on a scalar field, use chain rule of differentiability to find derivative of a composite function, use the sufficient condition to check for equality of mixed partial derivatives.
CO IV	Evaluate Jacobian matrix of a vector valued function as a tool for finding derivatives of vector valued functions, find stationary points, maxima, minima of vector fields, apply chain rule of differentiation to evaluate the derivative of a composite function.
	Paper II ALGEBRA – III Course Code : 302
CO I	Define elementary and invertible matrices, perform elementary row operations and convert a given matrix to its row echelon form to compute the rank of a matrix, define linear transformations, kernel and image of a linear transformation, state and verify Rank Nullity theorem for a given linear transformation, find the matrix of a linear transformation.

CO II	Define determinant as an n-linear skew symmetric functions, apply determinant to evaluate area and volume, compute the solution of n×n system of linear equations using Cramer's rule, explain linear dependence and independence using the concept of determinants.
CO III	Define dot product, inner product and general inner product space, orthogonal and orthonormal sets, find orthonormal basis of a vector space using Gram-Schmidt orthogonalization process, find orthogonal projections on a line.
	Paper III DISCRETE MATHEMATICS Course Code :USMT 303
CO I	Define permutation of objects, state basic results on permutation, Express permutations as a product of disjoint cycles, define a recurrence relation and obtain recurrence relation in counting problems, solve homogeneous and non homogeneous recurrence relation using various methods.
CO II	Define finite, countable and uncountable sets, state and prove various principles of preliminary counting, explain pigeon hole principle and its strong form and solve examples.
CO III	State principal of inclusion and exclusion and apply it to solve problems, Permutation and combination of sets and multi-sets, circular permutations, emphasis on solving problems, define derangements, solve examples using explicit formula
CO IV	Apply binomial and multinomial theorem in examples of counting, derive Euler's function $\emptyset(n)$, $n \in N$ and find $\emptyset(n)$
	T.Y.B.Sc
	Sem IV
	Paper I CALCULUS IV Course Code: USMT 401
CO I	Evaluate Upper/Lower Riemann sums, Upper/Lower integrals and state their properties, define Riemann integral on a closed and bounded interval, identify Riemann integrable functions using theorems, and use properties of Riemann integrable functions to solve rigorous problems
CO II	State Fundamental theorem of integral calculus, Mean Value theorem, Integration by parts and solve problems based on these theorems, identify Improper integrals-type 1 and type 2 and check convergence of improper integrals of type 1 and type 2 , using Abel's or Dirichlet's testo check for convergence of these improper integrals.

CO III	Identify Beta and Gamma functions, state their properties and the relationship between them, apply integration in finding area between curves, volumes of solids of revolution , lengths of plane curves, areas of surfaces of revolution.
	Paper II ALGEBRA IV Course Code: USMT 402
CO I	Introduced to group theory. Using the definitions of a group, abelian group, order of a group, centre of a group and normalizer of a group, solve examples of groups and explore its properties, find the order of elements of a group, define a subgroup and determine whether a non empty set is a subgroup of a group using necessary and sufficient conditions
CO II	Determine whether a given group is cyclic using the definition, apply the properties of a cyclic group to find subgroups of a cyclic group, list all generators of each subgroup of a cyclic group.
CO III	Define cosets, state Lagrange's theorem and its corollaries, State Euler's theorem and Fermat's theorem, Construct and manipulate group homomorphisms and isomorphisms. Testing a potential map using definitions to check for homomorphism, isomorphism
	Paper III ORDINARY DIFFERENTIAL EQUATIONS Course Code: USMT 403
CO I	Define a differential equation and ordinary differential equation, find the order and degree of a differential equation, state the existence and uniqueness theorem for first order linear differential equation, define Lipschitz function and verify Lipschitz condition for a given function, identify different types of differential equation and solve them using appropriate methods
CO II	Define homogeneous and non-homogeneous second order differential equations, solve such equations using different methods based on its types, find the general solution of a homogeneous and non-homogeneous second order ordinary differential equation.
CO III	Define system of differential equations and solve the system, define and evaluate Wronskian of linear system of differential equations, determine the solution of system of homogenous and non-homogeneous equations with constant coefficient.
	Sem V
	Paper I MULTIVARIABLE CALCULUS – II Course Code : USMT501
CO I	Define double and triple integrals and explain its geometrical significance in calculating area and volume, evaluate a double/triple integral by expressing it as an iterated integral, identify that a function of two/three variables is integrable over a closed and bounded region, simplify a calculation by changing the order of integration of a triple integral, change of variables

	formula, solve examples of double and triple integrals by converting it to polar, cylindrical and spherical coordinates, learn its applications in physics.
CO II	Define Line integrals of the gradient vector field, compute line integrals directly, using the fundamental theorem for line integrals, and using Green's theorem. evaluation of line integrals in physics applications
CO III	Understanding the architecture of curves and surfaces in plane and space etc., solve problems of area of such surfaces, define surface integrals of scalar-valued and vector fields defined on a surface, compute curl and divergence of a vector field, learnt elementary identities involving gradient, curl and divergence, compute surface integrals, directly, using Stokes' theorem and using the Gauss divergence theorem
	Paper II LINEAR ALGEBRA Course Code : USMT502
CO I	Define and explain quotient structures on vector space., learnt properties of inner product spaces and determine orthogonality in inner product spaces state and prove the first isomorphism theorem of vector space, show that a given map is an orthogonal transformation and determine whether it represents reflection or rotation, apply Cayley-Hamilton theorem to compute the inverse and powers of a given matrix.
CO II	Find characteristic polynomial and hence the eigen values and eigen vectors of a matrix, define similar polynomials, deduce that similar polynomials have same characteristic polynomial and hence same eigen vectors, find the minimal polynomial of a matrix.
CO III	Calculate algebraic and geometric multiplicity of eigen values of a given matrix and deduce if a matrix is diagonalizable, define a quadratic form and evaluate the rank and signature of a quadratic form, characterize positive definite matrices in terms of principal minors.
	Paper III TOPOLOGY OF METRIC SPACES Course Code : USMT503
CO I	Solve examples to verify a given set forms a metric space, explain properties of metric space, classify and explain open and closed sets, interior points , limit points, closure of a subset of metric space, closed sets in a metric space, and their properties, use Hausdorff property, find distance of a point from a given set.
CO II	Define sequences, convergent sequences and Cauchy sequences in a metric space, give examples of convergent and Cauchy sequences in infinite metric spaces, characterize limit points and closure in terms of sequences, define complete metric spaces and state nested interval theorem, apply Cantor's intersection theorem to show that the set of real numbers is uncountable
CO III	Define compact metric space using open cover, sequentially compact metric space and solve examples, explain properties of compact metric space, state and explain Heine Borel property, closed and boundedness property and Bolzano-Weierstrass property.

	Paper IV NUMERICAL ANALYSIS – I Course Code : USMT5A4
CO I	Define relative, absolute and percentage errors, find errors in different iterative methods, apply iterative methods based on first degree equation such as Newton Raphson method, secant method etc., to find roots of polynomial, find rate of convergence of various iterative methods, analyze the errors obtained in the numerical solution of problems.
CO II	Apply methods based on second degree equation like Muller method, Chebyshev method, Multipoint iteration method, apply iterative methods for polynomial equations such as Descartes rule of signs, Birge-vieta method etc., to find the roots of polynomials, find rate of convergence of various iterative methods.
CO III	Using appropriate numerical methods, determine approximate solutions to systems of linear equations, express the given system of linear equation in matrix form and apply Gaussian method to find the solution of the given system, use Triangularization methods such as Doolittle and Crout's method, Cholesky method etc., to find the solution of system of linear equations, find the largest and smallest Eigen value of a matrix using power method, find the Eigen values of symmetric matrices using Jacobi method.
	APPLIED COMPONENT Computer Programming and System Analysis Course code USACCS501
CO I	Have a broad understanding of database concepts and database management system software, major DBMS components and their function, write SQL commands to create tables and indexes, insert, update, delete data and query data in relational DBMS, prepare various database tables and join them using SQL commands
CO II	Reflect on the advantages and benefits of PL/SQL within a database environment, work on processes of Database Development and Administration using SQL and PL/SQL, declaring program variables and complex data types, developing logic within PL/SQL program blocks, use PL/SQL code constructs of IF-THEN-ELSE and LOOP types as well as syntax and command functions, solve Database problems using Oracle 9i SQL and PL/SQL, use Procedures and Functions.
CO III	Know the Java software architecture, and the design decisions which make Java software portable, efficient, secure and robust, learn how to configure a simple Java development environment, know the data types and flow control constructs of the Java language for simple procedural programming, create Java technology applications that leverage the object-oriented features of the Java language, such as encapsulation, inheritance, and polymorphism, execute a Java technology application from the command line, use Java technology data types and expressions, use arrays and other data collections.

CO IV	Explain the various methodologies to handle the exception mechanisms and the principles of inheritance, packages and interfaces, implement error-handling techniques using exception handling, understand what exceptions are and when and how they happen, understand the try catch finally statement.
	Sem VI
	Paper I BASIC COMPLEX ANALYSIS Course Code : USMT601
CO I	Understand the complex numbers algebraically and geometrically, Explain limits and convergence of sequences of complex numbers and results using properties of real sequences, Apply the Cauchy-Riemann equation to check the differentiability of a complex valued function, define harmonic functions, harmonic conjugate of a complex valued functions and find the same.
CO II	Evaluate the line integral and prove the Cauchy integral formula , prove Taylors theorem for analytic function , define and solve examples of Mobius transformations, explain properties of exponential function, trigonometric function, hyperbolic functions.
CO III	Represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.
CO IV	Apply the methods of complex analysis to evaluate definite integrals and infinite series.
	Paper II ALGEBRA Course Code : USMT602
CO I	Explain the significance of the notion of cosets, normal subgroups, and quotient groups, solve examples of group homomorphism, finding the kernel of a group homomorphism, group isomorphism, and their consequences, external direct product of a group and properties of external direct products.
CO II	Define algebraic structures like rings, integral domain, field, ideals, Commutative ring, quotient rings, subrings and use it to identify and construct their examples and identify non-examples, examples and properties of homomorphisms and isomorphisms of rings, define characteristic of a ring and find characteristic of some standard rings and integral domain and solve examples.
CO III	Define , classify principal ideal, prime and maximal ideals and prove theorems, determine whether the given ideal is a prime ideal and maximal ideal, define polynomial rings, divisibility in integral domain define associates, irreducible polynomials and primes, list the irreducibility tests and use it to determine the irreducibility of a given polynomial, define field, subfield and examples, characteristic of fields, characterization of fields in terms of maximal ideals, irreducible polynomials. construction of quotient field of an integral1 domain.
	Paper III TOPOLOGY OF METRIC SPACES AND REAL ANALYSIS Course Code : USMT603
CO I	Define continuity of function from one metric space to another using $\epsilon - \delta$ definition, use Characterization of continuity at a point in terms of sequences, open sets and closed sets to

	solve examples, prove algebra of continuous real valued functions in a metric space, continuity of composite functions, solve examples on uniform continuity of a metric space, Contraction mapping and fixed point theorem and its applications
CO II	Define connected and disconnected sets in metric space, explain the properties of connected sets, define path connectedness in $\mathbb{R}^n$ and solve examples. Show that path connected subset of $\mathbb{R}^n$ is connected, convex sets are path connected. define connected components and give examples of a connected set which is not path connected.
CO III	Define sequence of functions, point wise and uniform convergence of real value functions, show that point wise convergence does not imply uniform convergence, solve problems of pointwise and uniform convergence of sequence of functions
CO IV	Define series of functions and their convergence, state and prove Weierstrass M-test, solve examples, state and prove properties of uniform convergence such as continuity, differentiability and integrability, Consequences of these properties for series of functions, term by term differentiation and integration, solve examples based on these properties.
	Paper IV NUMERICAL ANALYSIS – II Course Code : USMT6A4
CO I	Define Basic concepts of operators Δ, E, ∇, form a difference table, find the relation between difference and derivatives of polynomial, perform interpolation such as linear, quadratic and cubic interpolation to find the polynomial, derive formula and solve problems using Newton forward formula and Newton backward formula, Stirling's Interpolation, explain results on interpolation error.
CO II	Evaluate numerical differentiation based on interpolation, perform piecewise interpolation such as linear, quadratic and cubic interpolation to find the polynomial, derive formula and solve problems using Lagrange's Bivariate interpolation and Newton's Bivariate interpolation.
CO III	Derive Newton-Cotes method, Simpson's 1/3, 3/8 rules, trapezoidal rule, composite Simpson's and trapezoidal rule, evaluate the numerical integration using Simpson's 1/8, 3/8 rules and trapezoidal rule, analyze the errors obtained in the numerical solution of problems
	APPLIED COMPONENT Computer Programming and System Analysis Course code USACCS601
CO I	Write and execute Java applets, use the graphics class, painting, repainting and updating an applet, sizing graphics, font class, draw graphical figures-lines and rectangle, circle and ellipse, drawing arcs, drawing polygons and Work with Colors: Color methods, setting the paint mode, use AWT package: Containers: Frame and Dialog classes, Components: Label; Button; Checkbox; Text Field, Text Area.

CO II	Will be able to identify Python object types, define the structure and components of a Python program, write loops, decision statements and functions and pass arguments in Python
CO III	Use lists, tuples and dictionaries in Python programs, use indexing and slicing to access data in Python programs, learn how to read and write files in python, design object-oriented programs with Python classes, use class inheritance in Python for reusability, use exception handling in Python application and error handling.
CO IV	Work with the Python standard library, describe data with statistics, and visualize it with line graphs and scatter plots, apply Python's symbolic math functions to solve algebraic problems.