B.Sc. MATHEMATICS PROGRAMME

Program Specific Outcomes (PSOs)

PO 1	Disciplinary knowledge
PO 2	Communications skills
PO 3	Critical thinking
PO 4	Analytical reasoning
PO 5	Problem solving
PO 6	Research-related skills
PO 7	Information/digital literacy
PO 8	Self-directed learning
PO 9	Lifelong learning
PO 10	Application skills
PO 11	Experimental skills
PO 12	Moral and ethical awareness/reasoning

COURSE OUTCOMES (COS)

CORE COURSE OUTCOMES (COs)

THEORY

CORE COURSE- I

Code: MTS1 B01 BASIC LOGIC & NUMBER THEORY

Cos	Course Outcome Statements
CO1	Prove results involving divisibility, greatest common divisor, least common multiple and a few applications.
CO2	Understand the theory and method of solutions of LDE.
CO3	Solve linear congruent equations.
CO4	Learn three classical theorems *viz*. Wilson's theorem, Fermat's little theorem and Euler's theorem and a few important consequences.

CORE COURSE- II

Code: MTS2 B02 CALCULUS OF SINGLE VARIABLE-1

CO 1	introduce students to the fundamental ideas of limit, continuity and differentiability and also to some basic theorems of differential calculus.
CO 2	sketching of curves and solving some optimization problems
CO 3	finding out the arc length of a plane curve, volume and surface areas of solids

CORE COURSE – III

CODE: B MTS3 B03 CALCULUS OF SINGLE VARIABLE-2

CO 1	introduction to the idea of improper integrals, their convergence and evaluation.
CO 2	students get the idea of parametrization of curves,
CO 3	Introducing other coordinate systems
CO 4	problems involving geometry of lines, curves, planes and surfaces in space
CO 5	ability to sketch curves in plane and space given in vector valued form.

CORE COURSE-IV

Code: MTS4 B04 LINEAR ALGEBRA

CO 1	Introducing Systems of Linear Equations & Matrices
CO 2	the students learn the fundamentals of linear algebra
CO 3	Understanding Properties of matrices and determinants
CO 4	Knowledge on General Vector Spaces
CO 5	the idea of diagonalization of a matrix

CORE COURSE- V

Code: MTS5 B05 ABSTRACT ALGEBRA

CO 1	understand the abstract notion of a group,
CO 2	learn several examples of groups
CO 3	taught to check whether an *algebraic system* forms a group or not
CO 4	are introduced to some fundamental results of group theory
CO 4	idea of structural similarity, the notion of cyclic group, permutation group

CORE COURSE- VI

Code: MTS5 B06 BASIC ANALYSIS

Cos	Course Outcome Statements
CO1	to learn and deduce rigorously many properties of real number system by assuming a few fundamental facts about it as axioms.
CO2	to know about sequences ,their limits, several basic and important theorems involving sequences and their applications .
CO3	to understand some basic topological properties of real number system such as the

	concept of open and closed sets, their properties, their characterization
CO4	to get a rigorous introduction to algebraic, geometric and topological structures of complex number system, functions of complex variable, their limit and continuity

CORE COURSE- VII

Code: MTS5 B07 NUMERICAL ANALYSIS

Cos	Course Outcome Statements
CO1	Understand several methods such as bisection method, fixed point iteration method, regula falsi method etc. to find out the approximate numerical solutions of algebraic and transcendental equations with desired accuracy.
CO2	Understand the concept of interpolation and also learn some well known interpolation techniques.
CO3	Understand a few techniques for numerical differentiation and integration and also realize their merits and demerits.
CO4	Find out numerical approximations to solutions of initial value problems and also to understand the efficiency of various methods.

CORE COURSE- VIII

Code: MTS5 B08 LINEAR PROGRAMMING

Cos	Course Outcome Statements
CO1	solve linear programming problems geometrically
CO2	understand the drawbacks of geometric methods
CO3	solve LP problems more effectively using Simplex algorithm via. the use of condensed tableau of A.W. Tucker
CO4	convert certain related problems, not directly solvable by simplex method, into a form that can be attacked by simplex method.
CO5	understand duality theory, a theory that establishes relationships between linear programming problems of maximization and minimization
CO6	understand game theory
CO7	solve transportation and assignment problems by algorithms that take advantage of the simpler nature of these problems

CORE COURSE – IX

Code: MTS5 B09 INTRODUCTION TO GEOMETRY AND THEORY OF EQUATIONS

Cos	Course Outcome Statements
CO1	Understand several basic facts about parabola, hyperbola and ellipse *(conics)* such as their equation in standard form, focal length properties, and reflection properties, their tangents and normal.
CO2	Recognise and classify conics.
CO3	Understand Kleinian view of Euclidean geometry.
CO4	Understand affine transformations, the inherent group structure, the idea of parallel projections and the basic properties of parallel projections.

CO5	Understand the fundamental theorem of affine geometry.
CO6	Learn to solve polynomial equations upto degree four.

CORE COURSE – X

Code: MTS6 B10 REAL ANALYSIS

Cos	Course Outcome Statements
CO1	State the definition of continuous functions, formulate sequential criteria for continuity and prove or disprove continuity of functions using this criteria.
CO2	Realise the difference between continuity and uniform continuity and equivalence of these ideas for functions on closed and bounded interval.
CO3	Understand the significance of uniform continuity in continuous extension theorem.
CO4	Develop the notion of Riemann integrability of a function using the idea of tagged partitions and calculate the integral value of some simple functions using the definition.
CO5	Understand a few basic and fundamental results of integration theory.
CO6	Formulate Cauchy criteria for integrability and a few applications of it. In particular they learn to use Cauchy criteria in proving the non integrability of certain functions.
CO7	Understand classes of functions that are always integrable
CO8	Understand two forms of fundamental theorem of calculus and their significance in the practical problem of evaluation of an integral.
CO9	Find a justification for 'change of variable formula' used in the practical problem of evaluation of an integral.
CO10	Prove convergence and divergence of sequences of functions and series
CO11	Understand the difference between pointwise and uniform convergence of sequences and series of functions
CO12	Answer a few questions related to interchange of limits.
CO13	Learn and find out examples/counter examples to prove or disprove the validity of several mathematical statements that arise naturally in the process/context of learning.
CO14	Understand the notion of improper integrals, their convergence, principal value and evaluation.
CO15	Learn the properties of and relationship among two important improper integrals namely beta and gamma functions that frequently appear in mathematics, statistics, science and engineering.

CORE COURSE –XI

Code: MTS6 B11 COMPLEX ANALYSIS

Cos	Course Outcome Statements
CO1	to understand the difference between differentiability and analyticity of a complex

	function and construct examples.
CO2	to understand necessary and sufficient condition for checking analyticity.
CO3	to know of harmonic functions and their connection with analytic functions
CO4	to know a few elementary analytic functions of complex analysis and their properties.
CO5	to understand definition of complex integral, its properties and evaluation.
CO6	to know a few fundamental results on contour integration theory such as Cauchy's theorem, Cauchy-Goursat theorem and their applications.
CO7	to understand and apply Cauchy's integral formula and a few consequences of it such as Liouville's theorem, Morera's theorem and so forth in various situations.
CO8	to see the application of Cauchy's integral formula in the derivation of power series expansion of an analytic function.
CO9	to know a more general type of series expansion analogous to power series expansion *viz. Laurent's series expansion* for functions having *singularity*.
CO10	to understand how Laurent's series expansion lead to the concept of *residue*, which in turn provide another fruitful way to evaluate complex integrals and, in some cases, even real integrals.
CO11	to see another application of residue theory in locating the region of zeros of an analytic function.

CORE COURSE –XII

Code:MTS6 B12 CALCULUS OF MULTI VARIABLES6 B12 CALCULUS OF MULTI VARIABLE

Cos	Course Outcome Statements
CO1	Understand several contexts of appearance of multivariable functions and their representation using graph and contour diagrams.
CO2	Formulate and work on the idea of limit and continuity for functions of several variables.
CO3	Understand the notion of partial derivative, their computation and interpretation.
CO4	Understand chain rule for calculating partial derivatives.
CO5	Get the idea of directional derivative, its evaluation, interpretation, and relationship with partial derivatives.
CO6	Understand the concept of gradient, a few of its properties, application and interpretation.
CO7	Understand the use of partial derivatives in getting information of tangent plane and normal line.
CO8	Calculate the maximum and minimum values of a multivariable function using second derivative test and Lagrange multiplier method.
CO9	Find a few real life applications of Lagrange multiplier method in optimization problems.
CO10	Extend the notion of integral of a function of single variable to integral of functions of two and three variables.

CO11	Address the practical problem of evaluation of double and triple integral using Fubini's theorem and change of variable formula.
CO12	Realise the advantage of choosing other coordinate systems such as polar, spherical, cylindrical etc. in the evaluation of double and triple integrals .
CO13	See a few applications of double and triple integral in the problem of finding out surface area ,mass of lamina, volume, centre of mass and so on.
CO14	Understand the notion of a vector field, the idea of curl and divergence of a vector field, their evaluation and interpretation.
CO15	Understand the idea of line integral and surface integral and their evaluations.
CO16	Learn three major results viz. Green's theorem, Gauss's theorem and Stokes' theorem of multivariable calculus and their use in several areas and directions.

CORE COURSE –XIII

Code: MTS6 B13 DIFFERENTIAL EQUATIONS

Cos	Course Outcome Statements
CO1	Students could identify a number of areas where the modelling process results in a differential equation.
CO2	They will learn what an ODE is, what it means by its solution, how to classify DEs, what it means by an IVP and so on.
CO3	They will learn to solve DEs that are in linear, separable and in exact forms and also to analyse the solution.
CO4	They will realise the basic differences between linear and non linear DEs and also basic results that guarantees a solution in each case.
CO5	They will learn a method to approximate the solution successively of a first order IVP.
CO6	They will become familiar with the theory and method of solving a second order linear homogeneous and nonhomogeneous equation with constant coefficients.
CO7	They will learn to find out a series solution for homogeneous equations with variable coefficients near ordinary points.
CO8	Students acquire the knowledge of solving a differential equation using Laplace method which is especially suitable to deal with problems arising in engineering field.
CO9	Students learn the technique of solving partial differential equations using the method of separation of variables

MATHEMATICS ELECTIVE CORE COURSE- III (Theory)

CODE:MTS6 B14 (E01) GRAPH THEORY

CO 1	Knowledge on basic definitions of graph
CO 2	Matrix representation
CO 3	Knowledge of spanning trees
CO 4	Euler and Hamilton graphs

OPEN COURSE

OPEN COURSE- I (Theory)

CODE: MTS5 D03 LINEAR MATHEMATICAL MODELS

CO 1	Knowledge of Linear Functions LINEAR MATHEMATICAL MODELS
CO 2	Properties of matrices and determinants
CO 3	Linear Programming: The Graphical Method
	Linear Programming: The Simplex Method

COMPLEMENTARY COURSE

Theory Course- I

Code: MTS1 C01:MATHEMATICS1

CO 1	Introducing derivative, Limits and Linear Approximation and Tangent Lines
CO 2	Understanding derivatives as rate of change
CO 3	Applications of derivatives and graphing
CO 4	Integration and its application

Theory Course- II

Code: MTS2 C02:MATHEMATICS-2

CO 1	Introducing polar coordinates
CO 2	Graphing in polar coordinates
CO 3	Limits of sequences and series
CO 4	Introduction to vector spaces
CO 5	Properties of determinant and matrices
CO 6	Diagonalization

Theory Course- III

Code: MTS3 C03:MATHEMATICS3

Cos	Course Outcome Statements
CO1	Understand several contexts of appearance of multivariable functions and their representation using graph and contour diagrams.
CO2	Formulate and work on the idea of limit and continuity for functions of several variables.
CO3	Understand the notion of partial derivative, their computation and interpretation.
CO4	Understand chain rule for calculating partial derivatives.
CO5	Get the idea of directional derivative, its evaluation, interpretation, and relationship with partial derivatives.
CO6	Understand the concept of gradient, a few of its properties, application and interpretation.
CO7	Understand the use of partial derivatives in getting information of tangent plane and normal line.
CO8	Calculate the maximum and minimum values of a multivariable function using second derivative test and Lagrange multiplier method.
CO9	Find a few real life applications of Lagrange multiplier method in optimization problems.
CO10	Extend the notion of integral of a function of single variable to integral of functions of two and three variables.
CO11	Address the practical problem of evaluation of double and triple integral using Fubini's theorem and change of variable formula.
CO12	Realise the advantage of choosing other coordinate systems such as polar, spherical, cylindrical etc. in the evaluation of double and triple integrals .
CO13	See a few applications of double and triple integral in the problem of finding out surface area ,mass of lamina, volume, centre of mass and so on.
CO14	Understand the notion of a vector field, the idea of curl and divergence of a vector field, their evaluation and interpretation.
CO15	Understand the idea of line integral and surface integral and their evaluations.
CO16	Learn three major results viz. Green's theorem, Gauss's theorem and Stokes' theorem of multivariable calculus and their use in several areas and directions.
CO 17	Understand complex functions, its continuity differentiability with the use of Cauchy-Riemann equations
CO 18	Evaluate complex integrals using Cauchy's integral theorem and Cauchy's integral formula, understand the series expansion of analytic function

Theory Course- IV

Code: MTS4 C04:MATHEMATICS4

Cos	Course Outcome Statements
CO1	Students could identify a number of areas where the modelling process results in a

	differential equation.
CO2	They will learn what an ODE is, what it means by its solution, how to classify DEs, what it means by an IVP and so on.
CO3	They will learn to solve DEs that are in linear, separable and in exact forms and also to analyse the solution.
CO4	They will realise the basic differences between linear and non linear DEs and also basic results that guarantee a solution in each case.
CO5	They will learn a method to approximate the solution successively of a first order IVP.
CO6	They will become familiar with the theory and method of solving a second order linear homogeneous and nonhomogeneous equation with constant coefficients.
CO7	They will learn to find out a series solution for homogeneous equations with variable coefficients near ordinary points.
CO8	Students acquire the knowledge of solving a differential equation using Laplace method which is especially suitable to deal with problems arising in engineering field.
CO9	Students learn the technique of solving partial differential equations using the method of separation of variables