Department of Mathematics

Programme Specific Outcomes(PSOs)

PSOI: Realize the mathematical analysis, modeling and soft computing of real life problems which have rigorous implications in other basic science and engineering subjects.

PSO2: Form mathematical ideas from basic axioms' which have applications in industrial problems.

PSO3: To have power over basic subject knowledge required for advanced studies and research in pure and applied mathematics and statistics, applied courses like operations and management science, engineering and industrial optimization, etc.

PSO4: Realize, formulate and use quantitative models arising in social science, business and other contexts.

PSO5: Cultivate of problem solving skills, thinking, creativity through assignments, project work, problem solving skills, creative talent and power of communication are required for various kinds of employment.

Course Outcomes

	Semester 1:
1.1.a	**Algebra-I (MTMG CC1/GE1, CO11):** To make students understand the complex number and functions and its solution.
1.1.b	**Algebra-I (MTMG CC1/GE1, CO12):** To discuss the various types of polynomials and its solutions, applications of Rolle's theorem.
1.1.c	**Algebra-I (MTMA CC1/GE1, CO13):** To know the properties of matrices and how to solve problems using matrix operations and find out the rank of matrices.
1.2.a	**Differential Calculus-I (MTMG CC1/GE1, CO14):** To make students understand the concept of real number systems and its limits, derivatives.
1.2.b	**Differential Calculus-I (MTMG CC1/GE1, CO15):** To discuss the functions of several variable and limits, derivative, Schwarz's Theorem on Commutative property of mixed derivatives, and Euler's Theorem on homogeneous function of two and three variables.
1.2.c	**Differential Calculus-I (MTMA CC1/GE1, CO16):** To solve problems related to application of differential calculus.
1.3.a	**Differential Equation-I(MTMG CC1/GE1, CO17):** To learn about Order, degree and solution of an ordinary differential equation (ODE) in presence of arbitrary constants, formation of ODE.
1.3.b	**Differential Equation-I(MTMG CC1/GE1, CO18):** To find out solutions of different types of ODE by several methods.
1.4.a	**Coordinate Geometry (MTMG CC1/GE1, CO19):** To know about Transformations of Rectangular axes : Translation, Rotation and their combinations, Invariants.
1.4.b	**Coordinate Geometry (MTMG CC1/GE1, CO20):** To make understand the students about the features of general equation of second degree in x and y : Reduction to canonical forms, classification of conic.
1.4.c	**Coordinate Geometry (MTMG CC1/GE1, CO21):** To know about the characteristic of pair of straight lines : Condition that the general equation of 2nd degree in x and y may represent two straight lines, point of intersection of two intersecting straight lines, angle between two lines given by $ax^2+2hxy+by^2 = 0$, equation

of bisectors, equation of two lines joining the origin to the points in which a line meets a conic.

1.4.d **Coordinate Geometry (MTMG CC1/GE1, CO22):** To learn about equations of pair of tangents from an external point, chord of contact, poles and polars in case of general conic : particular cases for Parabola, Ellipse, Circle, Hyperbola.

1.4.e **Coordinate Geometry (MTMG CC1/GE1, CO23):** To make understand the properties of polar equation of straight lines and circles, polar equation of a conic referred to a focus as pole, equation of chord joining two points, equations of tangent and normal.

1.4.f **Coordinate Geometry (MTMG CC1/GE1, CO24):** To know about properties of sphere and its tangent plane, and Right circular cone.

Semester 2:

2.1.a **Differential Calculus-II (MTMG CC2/GE2, CO25):** To learn about sequence of real numbers : definition of bounds of a sequence and monotone sequence, limit of a sequence, statements of limit theorems.

2.1.b **Differential Calculus-II (MTMG CC2/GE2, CO26):** To get concept of convergence and divergence of monotone sequences-applications of the theorems, in particular, definition of *e*. Statement of Cauchy's general principle of convergence and its application.

2.1.c **Differential Calculus-II (MTMG CC2/GE2, CO27):** To know the properties of infinite series of constant terms, convergence and divergence (definitions), Cauchy's principle as applied to infinite series (application only), series of positive terms : statements of comparison test, D. AIembert's Ratio test, Cauchy's nth root test and Raabe's test Applications, Alternating series, Statement of Leibnitz test and its applications.

2.1.d **Differential Calculus-II (MTMG CC2/GE2, CO28):** To make the students understand about real-valued functions defined on an interval: Statement of Rolle's Theorem and its geometrical interpretation, Mean value theorems of Lagrange and Cauchy, Statements of Taylor's and Maclaurin's Theorems, indeterminate forms : L'Hospital's rule.

2.1.e **Differential Calculus-II (MTMG CC2/GE2, CO29):** To know about application of the principle of Maxima and Minima for a function of single variable in geometrical, physical and to other problems, maxima and minima of functions of not more than three variables Lagrange's Method of undetermined multiplier - Problems only.

2.2.a **Differential Equation-II(MTMG CC2/GE2, CO30):** To know the types of linear ordinary differential equations ant its solution prosudures: Linear homogeneous equations with constant coefficients, Linear non-homogeneous equations, The method of variation of parameters, The Cauchy-Euler equation, Simultaneous differential equations, Simple eigenvalue problem.

2.2.b **Differential Equation-II(MTMG CC2/GE2, CO31):** To know the partial differential equations and its solution procedures: Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order, Lagrange's method, Charpit's method.

2.3.a **Vector Algebra (MTMG CC2/GE2, CO32):** To learn the properties of vector algebra and its application in geometry and mechanics: Addition of Vectors, Multiplication of a Vector by a Scalar. Collinear and Coplanar Vectors. Scalar and Vector products of two and three vectors. Simple applications to problems of Geometry. Vector equation of plane and straight line. Volume of Tetrahedron. Applications to problems of Mechanics (Work done and Moment).

2.4.a **Discrete Mathematics (MTMG CC2/GE2, CO33):** To know the number systems and its application in real life problems: Integers : Principle of Mathematical Induction. Division algorithm. Representation of integer in an arbitrary base. Prime Integers. Some properties of prime integers. Fundamental theorem of Arithmetic. Euclid's Theorem. Linear Diophantine equations. Statement of Principle of Mathematical Induction, Strong form of Mathematical induction. Applications in different problems. Proofs of division algorithm. Representation of an integer uniquely in an arbitrary base, change of an integer from one base to another base. Computer operations with integers ˆa" Divisor of an integer, g.c.d. of two positive integers, prime integer, Proof of Fundamental theorem, Proof of Euclid's Theorem. To show how to find all prime numbers less than or equal to a given positive integer. Problems related to prime number. Linear Diophantine equation ˆa" when such an equation has solution, some applications.

2.4.b **Discrete Mathematics (MTMG CC2/GE2, CO34):** To know the congruence operations and its application: Congruences : Congruence relation on integers, Basic properties of this relation. Linear congruences, Chinese Remainder Theorem. System of Linear congruences. Linear Congruence, to show how to solve these congruences, Chinese remainder theorem ˆa" Statement and proof and some applications. System of linear congruences, when solution exists ˆa" some applications.

2.4.c **Discrete Mathematics (MTMG CC2/GE2, CO35):** Application of Congruences : Divisibility tests.

Check-digit and an ISBN, in Universal product Code, in major credit cards. Error detecting capability.Using Congruence, develop divisibility tests for integers based on their expansions with respect to different bases. Show that congruence can be used to schedule Round-Robin tournaments. Check digits for different identification numbers ˆa“ International standard book number, universal product code etc. Theorem regarding error detecting capability.

2.4.d **Discrete Mathematics (MTMG CC2/GE2, CO36):** Congruence Classes : Congruence classes, addition and multiplication of congruence classes. Fermat's little theorem. Euler's theorem. Wilson's theorem. Some simple applications. Definition of Congruence Classes, properties of Congruence classes, addition and multiplication, existence of inverse. Fermat's little theorem. Euler's theorem. Wilson's theorem - Statement, proof and some applications.

2.4.e **Discrete Mathematics (MTMG CC2/GE2, CO37):** To know Boolean algebra : Boolean Algebra, Boolean functions, Logic gates, Minimization of circuits.

Semester 3:

3.1.a **Integral Calculus (MTMG CC3/GE3, CO38):** Evaluation of definite integrals. Integration as the limit of a sum (with equally spaced as well as unequal intervals). Reduction formulae, Definition of Improper Integrals : Statements of (i) μ-test (ii) Comparison test (Limit from excluded) - Simple problems only. Use of Beta and Gamma functions (convergence and important relations being assumed).Working knowledge of double integral.

3.1.b **Integral Calculus(MTMG CC3/GE3, CO39):** Applications of Integration in geometry: Rectification, Quadrature, volume and surface areas of solids formed by revolution of plane curve and areas problems only.

3.2.a **Numerical Methods(MTMG CC3/GE3, CO40):** To learn numerical techniques to solve scientific problems: Approximate numbers, Significant figures, Rounding off numbers. Error : Absolute, Relative and percentage. Operators.

3.2.b **Numerical Methods(MTMG CC3/GE3, CO41):** To learn Interpolation : The problem of interpolation equispaced arguments Difference Tables, Deduction of Newton's Forward Interpolation Formula, remainder term (expression only). Newton's Backward interpolation Formula (Statement only) with remainder term. Unequally- spaced arguments Lagrange's Interpolation Formula (Statement only). Numerical problems on Interpolation with both equally and unequally spaced arguments.

3.2.c **Numerical Methods(MTMG CC3/GE3, CO42):** To Know Numerical Integration : Trapezoidal and Simpson's 1/3-rd formula (statement only). Problems on Numerical Integration.

3.2.d **Numerical Methods(MTMG CC3/GE3, CO43):** Solution of Numerical Equation : To find a real root of an algebraic or transcendental equation. Location of root (tabular method), Bisection method, Newton-Raphson method with geometrical significance, Numerical Problems. (Note : Emphasis should be given on problems)

3.3.a **Linear Programming(MTMG CC3/GE3, CO44):** Motivation of Linear Programming problem. Statement of L.P.P. Formulation of L.P.P. Slack and Surplus variables. L.P.P. is matrix form. Convex set, Hyperplane, Extreme points, convex Polyhedron, Basic solutions and Basic Feasible Solutions (B.F.S.). Degenerate and Non-degenerate B.F.S.

3.3.b **Linear Programming(MTMG CC3/GE3, CO45):** The set of all feasible solutions of an L.P.P. is a convex set. The objective function of an L.P.P. assumes its optimal value at an extreme print of the convex set of feasible solutions, A.B.F.S. to an L.P.P. corresponds to an extreme point of the convex set of feasible solutions.

3.3.c **Linear Programming(MTMG CC3/GE3, CO46):** Fundamental Theorem of L.P.P. (Statement only) Reduction of a feasible solution to a B.F.S. Standard form of an L.P.P. Solution by graphical method (for two variables), by simplex method and method of penalty. Concept of Duality. Duality Theory. The dual of the dual is the primal. Relation between the objective values of dual and the primal problems. Dual problems with at most one unrestricted variable, one constraint of equality. Transportation and Assignment problem and their optimal solutions.

Semester 4:

4.1.a **Algebra-II(MTMG CC4/GE4, CO47):** Introduction of Group Theory : Definition and examples taken from various branches (example from number system, roots of Unity, 2×2 real matrices, non singular real matrices of a fixed order). Elementary properties using definition of Group. Definition and examples of sub-group - Statement of necessary and sufficient condition and its applications.

4.1.b **Algebra-II(MTMG CC4/GE4, CO48):** Definitions and examples of (i) Ring, (ii) Field, (iii) Sub-ring, (iv) Sub- field.

4.1.c **Algebra-II(MTMG CC4/GE4, CO49):** Concept of Vector space over a Field : Examples, Concepts of Linear combinations, Linear dependence and independence of a finite number of vectors, Sub- space, Concepts of generators and basis of a finite dimensional vector space. Problems on formation of basis of a vector space (No proof required).

4.1.d **Algebra-II(MTMG CC4/GE4, CO50):** Real Quadratic Form involving not more than three variables (problems only).

4.1.d **Algebra-II(MTMG CC4/GE4, CO51):** Characteristic equation of square matrix of order not more than three determination of Eigen Values and Eigen Vectors (problems only). Statement and illustration of Cayley-Hamilton Theorem.

4.2.a **Algebra-II(MTMG CC4/GE4, CO52):** Characteristic equation of square matrix of order not more than three determination of Eigen Values and Eigen Vectors (problems only). Statement and illustration of Cayley-Hamilton Theorem.

4.2.b **Computer Science & Programming(MTMG CC4/GE4, CO53):** Positional Number System. Binary to Decimal and Decimal to Binary. Other systems. Binary Arithmetic. Octal, Hexadecimal, etc. Storing of data in a Computer - BIT, BYTE, WORD etc. Coding of a data-ASCII, etc.

4.2.c **Computer Science & Programming(MTMG CC4/GE4, CO54):** Programming Language : Machine language, Assembly language and High level language, Compiler and interpreter. Object Programme and source Programme. Ideas about some HLL– e.g. BASIC, FORTRAN, C, C++, COBOL, PASCAL, etc.

4.2.d **Computer Science & Programming(MTMG CC4/GE4, CO55):** Algorithms and Flow Charts– their utilities and important features, Ideas about the complexities of an algorithm. Application in simple problems. FORTRAN 77/90: Introduction, Data Type– Keywords, Constants and Variables - Integer, Real, Complex, Logical, character, subscripted variables, Fortran Expressions.

4.3.a **Probability & Statistics (MTMG CC4/GE4, CO56):** Elements of probability Theory : Random experiment, Outcome, Event, Mutually Exclusive Events, Equally likely and Exhaustive. Classical definition of probability, Theorems of Total Probability, Conditional probability and Statistical Independence. Baye's Theorem. Problems, shortcoming of the classical definition. Axiomatic approach problems, Random Variable and its Expectation, Theorems on mathematical expectation. Joint distribution of two random variables.

4.3.b **Probability & Statistics (MTMG CC4/GE4, CO57):** Theoretical Probability Distribution Discrete and Continuous (p.m.f., p.d.f.) Binomial, Poisson and Normal distributions and their properties.

4.3.c **Probability & Statistics (MTMG CC4/GE4, CO58):** Elements of Statistical Methods. Variables, Attributes. Primary data and secondary data, Population and sample. Census and Sample Survey. Tabulation Chart and Diagram, Graph, Bar diagram, Pie diagram etc. Frequency Distribution Un-grouped and grouped cumulative frequency distribution. Histogram, Frequency curve, Measures of Central tendencies. Averages : AM,; GM, HM, Mean, Median and Mode (their advantages and disadvantages). Measures of Dispersions - Range, Quartile Deviation, Mean Deviation, Variance / S.D., Moments, Skewness and Kurtosis.

4.3.d **Probability & Statistics (MTMG CC4/GE4, CO59):** Sampling Theory : Meaning and objects of sampling. Some ideas about the methods of selecting samples, Statistic and parameter, Sampling Proportion. Four fundamental distributions, derived from the normal: (i) standard Normal Distribution, (ii) Chi-square distribution (iii) Student's distribution (iv) Snedecor's F-distribution. Estimation and Test of Significance. Statistical Inference. Theory of estimation Point estimation and Interval estimation. Confidence Interval / Confidence Limit. Statistical Hypothesis - Null
Hypothesis and Alternative Hypothesis. Level of significance. Critical Region. Type I and II error. Problems.

4.3.e **Probability & Statistics (MTMG CC4/GE4, CO60):** Bivariate Frequency Distribution. Scatter Diagram, Co-relation co-efficient Definition and properties. Regression lines.

Semester 3:

4.4.a **Skill Enhancement Course(SEC A, CO61):** C Programming Language:
An overview of theoretical computers, history of computers, overview of architecture of computer, compiler, assembler, machine language, high level language, object oriented language, programming language and importance of C programming. Constants, Variables and Data type of C-Program: Character set. Constants and variables data types, expression, assignment statements, declaration.
• Operation and Expressions: Arithmetic operators, relational operators, logical operators.
• Decision Making and Branching: decision making with if statement, if-else statement, Nesting if statement, switch statement, break and continue statement.
• Control Statements: While statement, do-while statement, for statement.

	• Arrays: One-dimension, two-dimension and multidimensional arrays, declaration of arrays, initialization of one and multi-dimensional arrays. • User-defined Functions: Definition of functions, Scope of variables, return values and their types, function declaration, function call by value, Nesting of functions, passing of arrays to functions, Recurrence of function. Introduction to Library functions.
	Semester 4:
4.5.a	**Skill Enhancement Course(SEC B, CO62):** To enhance mathematical logic: Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators.
4.5.b	**Skill Enhancement Course(SEC B, CO63):** General Notions : Formal language, object and meta language, general definition of a Formal Theory/ Formal Logic.
4.5.c	**Skill Enhancement Course(SEC B, CO64):** Propositional Logic : Formal theory for propositional calculus, derivation, proof, theorem, deduction theorem, conjunctive and disjunctive normal forms, semantics, truth tables, tautology, adequate set of connectives, applications to switching circuits, logical consequence, consistency, maximal consistency, Leindenbaum lemma, soundness and completeness theorems, algebraic semantics.
4.5.d	**Skill Enhancement Course(SEC B, CO65):** Predicate Logic : First order language, symbolizing ordinary sentences into first order formulae, free and bound variables, interpretation and satisfiability, models, logical validity, formal theory for predicate calculus, theorems and derivations, deduction theorem, equivalence theorem, replacement theorem, choice rule, Prenex normal form, soundness theorem, completeness theorem, compactness theorem, First Order Theory with equality, examples of First Order Theories (groups, rings, fields etc.).
	Semester 5:
5.1.a	**Skill Enhancement Course (SEC A, CO66): Object Oriented Programming in C++:**Programming paradigms, characteristics of object oriented programming languages, brief history of C++, structure of C++ program, differences between C and C++, basic C++ operators, Comments, working with variables, enumeration, arrays and pointer.
5.1.b	**Skill Enhancement Course (SEC A, CO67):** Objects, classes, constructor and destructors, friend function, inline function, encapsulation, data abstraction, inheritance, polymorphism, dynamic binding, operator overloading, method overloading, overloading arithmetic operator and comparison operators.
5.1.c	**Skill Enhancement Course (SEC A, CO68):** Template class in C++, copy constructor, subscript and function call operator, concept of namespace and exception handling.
	Semester 6:
6.1.a	**Skill Enhancement Course (SEC B, CO69):** Boolean Algebra: Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, maximal and minimal elements, lattices as ordered sets, complete lattices, lattices as algebraic structures, sublattices, products and homomorphisms. Definition, examples and properties of modular and distributive lattices, Boolean algebras.
6.1.b	**Skill Enhancement Course(SEC-B, CO70):** Boolean polynomials, minimal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, switching circuits and minimization of switching circuits using Boolean algebra.
	Semester 5/6:
5-6.1.a	**Discipline Specific Elective(DSE-A, CO71):** Particle Dynamics: Velocity and Acceleration of a particle. Expressions for velocity and acceleration in rectangular Cartesian and polar co-ordinates for a particle moving in a plane. Tangential and normal components of velocity and acceleration of a particle moving along a plane curve.
5-6.1.b	**Discipline Specific Elective(DSE-A, CO72):** Concept of Force : Statement and explanation of Newton's laws of motion. Work, power and energy. Principles of conservation of energy and momentum. Motion under impulsive forces. Equations of motion of a particle (i) moving in a straight line, (ii) moving in a plane.
5-6.1.c	**Discipline Specific Elective(DSE-A, CO73):** Study of motion of a particle in a straight line under (i) constant forces, (ii) variable forces (S.H.M., Inverse square law, Damped oscillation, Forced and Damped oscillation, Motion in an elastic string). Equation of Energy. Conservative forces.
5-6.1.d	**Discipline Specific Elective(DSE-A, CO74):** Motion in two dimensions : Projectiles in vacuum and in a

medium with resistance varying linearly as velocity. Motion under forces varying as distance from a fixed point.

5-6.1.e **Discipline Specific Elective(DSE-A, CO75):** Central orbit. Kepler's laws of motion. Motion under inverse square law.

5-6.2.a **Discipline Specific Elective(DSE-A, CO76):** Graph Theory:
Definition, examples and basic properties of graphs, pseudographs, complete graphs, bi-partite graphs, isomorphism of graphs.

5-6.2.b **Discipline Specific Elective(DSE-A, CO77):** Paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

5-6.2.c **Discipline Specific Elective(DSE-A, CO78):** Definition of Trees and their elementary properties. Definition of Planar graphs, Kuratowski's graphs.

5-6.3.a **Discipline Specific Elective(DSE-B, CO79):** Advanced Calculus:
Concept of Point-wise and Uniform convergence of sequence of functions and series of functions with special reference of Power Series. Statement of Weierstrass M-Test for Uniform convergence of sequence of functions and of series of functions. Simple applications. Statement of important properties like boundedness, continuity, differentiability and integrability of the limit function of uniformly convergent sequence of functions and of the sum function of uniformly convergent series of functions. Determination of Radius of convergence of Power Series. Statement of properties of continuity of sum function power series. Term by term integration and Term by term differentiation of Power Series. Statements of Abel's Theorems on Power Series. Convergence of Power Series. Expansions of elementary functions such as e^x, $\sin x$, $\log(1+x)$, $(1+x)^n$. Simple problems.

5-6.3.b **Discipline Specific Elective(DSE-B, CO80):** Periodic Fourier series on $(-\pi, \pi)$: Periodic function. Determination of Fourier coefficients. Statement of Dirichlet's conditions of convergence and statement of the theorem on convergence of Fourier Sine and Cosine series.

5-6.3.c **Discipline Specific Elective(DSE-B, CO81):** Laplace Transform and its application to ordinary differential equation. Laplace Transform and Inverse Laplace Transform. Statement of Existence theorem. Elementary properties of Laplace Transform and its Inverse. Application to the solution of ordinary differential equation of second order with constant coefficients.

5-6.4.a **Discipline Specific Elective(DSE-B, CO82):** Mathematical Finance:
Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods)

5-6.4.b **Discipline Specific Elective(DSE-B, CO83):**Comparison of NPV and IRR. Bonds, bond prices and yields. Floating-rate bonds, immunization. Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints).

Mapping of PSOs & Cos

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	√	√	√	√	√
CO2	√	√	√	√	√
….	√	√	√	√	√
…..	√	√	√	√	√
	√	√	√	√	√
CO83	√	√	√	√	√