Syllabus (CBCS – OC 66) (A.Y. 2017-18 onwards)

PSO1: Students will be able to acquire core knowledge in Mathematics and develop analytical reasoning skills.

PSO2: Learn the knowledge of python programming and Geogebra in Mathematics.

PSO3: Develop a skill in solving applied mathematics problems such as Ordinary Differential Equations, inventory models, transportation models, Project management, maximising profit and Queuing models. .

PSO4: Develop proficiency in statistical data analysis & interpretation of the data using 'R' software..

PSO5: Develop skills in solving various problems using numerical techniques

Paper No	Semester	Title	Credits
MTC101	I	Calculus and Numerical Methods	4 + 2

SYLLABUS

1. Real Number System: Algebra of real number system, Axioms of order structure in , Upper and Lower bounds of subsets of , lub of subsets of , Order completeness of , Archimedean property, Intervals and their types, Nested interval Theorem, Absolute value and their properties.**[12 hours]**

2. Real Sequences: Real Sequence (Definition and examples), Range of a sequence, Bounded sequence, Convergence of a sequence (Definition and examples), Uniqueness of limit of sequence, Algebra of sequences, Sandwich Lemma, Monotonic sequences and their convergence, Subsequence of a sequence (Definition and examples), Properties of subsequences, Bolzano Weierstrass theorem.**[12 hours]**

3. Limits and Continuity: Neighbourhood of a point, Deleted neighbourhood of a point, Limit of a function at a point (Definition and examples) Uniqueness of a limit, Algebra of limits, Continuity of a function at a point (Definition and examples), Algebra of continuous of function, Left hand limit, Right hand limit, Types of discontinuities, Sequential continuity, Some more properties of continuous functions, Boundedness of continuous function on a closed interval, Intermediate value theorem for continuous functions, Image of the closed interval under a continuous function, Attaining maximum and minimum of a continuous function on closed interval, Fixed point of a function, Fixed point theorem for continuous function.**[12 hours]**

4. Derivatives and its Applications: Derivative of a function at a point (Definition and examples), Geometric interpretation of a derivative, Algebra of derivatives, Chain rule, Some more properties of the derivative, Darboux's theorem for differentiable functions, Intermediate value theorem for differentiable functions, Rolle's theorem and its geometric significance, Lagranges mean value theorem and its geometric significance, Cauchy's mean value theorem and its geometric significance, Monotonic functions (Definition and examples), Monotonic functions and derivatives, Higher order derivatives, Taylor's theorem, Mclaurin's theorem, Taylor's and Mclaurin's series expansions, Leibnitz rule for higher order derivative of product of functions, Stationary points and their classification, Local maxima and Local minima, Condition for a stationary point to be local maxima and minima, Indeterminate forms of the type , , , , , , . **[15 hours]**

5. Numerical Methods:

Calculus of Finite differences: Operators Δ, ∇ ,& E . Difference Tables. Properties of Δ, ∇ , & E. Fundamental Theorem of Difference Calculus. Expression of any value of a function in terms of leading term and leading differences of a difference table. Method of separation of symbols.

Interpolation and Extrapolation: Newton's forward and backward interpolation formulae. Lagrange's Interpolation formula . Newton's Divided Difference formula.

Examples based on the above formulae.

Numerical Differentiation and Integration: Differentiation formulae for equidistant arguments. Examples. General quadrature formula for equidistant ordinates (Newton –Cotes Formula Or Gauss Legendre quadrature formulae). Trapezoidal rule and its Geometrical interpretation. Simpson's one third rule, Simpson's three-eighth rule. Weddle's rule (Only Statements)

Solution of Algebraic and transcendental Equations: Method of Bisection, Regula-Falsi Method, Newton-Raphson Method and their Computation scheme. Special Cases of Newton-Raphson Method like finding q^{th} root of a positive real number'd' and finding reciprocal of a positive real number 'd' without using division. **[09 hours]**

Learning Objectives:

- To study the concept of real number system, L.U.B and G.L.B of subsets of IR, order completeness and Archimedean property, intervals and properties of absolute valued function.
- To study the convergence of real number sequences, monotone sequences, and subsequences.
- To study the concept of neighbouzrhood of a point, limit of a function, continuity, types of discontinuities and properties of continuous functions.

- To study the theory of derivatives, Rolle’s Theorem, Lagrange’s Theorem and their interpretation, Taylor/Maclaurin series expansion, maxima and minima and indeterminate forms.
- To study the iterative procedures to solve transcendental equations to interpolate, integrate and differentiate.

Course Outcomes:

After completion of this course, a student should be able to:

- Apply the properties of absolute value function, classify the sequence as convergent or divergent.
- Check if a function is continuous and identify the types of discontinuities.
- Use L’Hospitals rule to find limits of indeterminate forms.
- Find Taylors/Maclauirn series expansion, find and classify stationary points and find local maxima and minima of a function.
- Solve numerically any transcendental equation, interpolate, integrate and differentiat

Paper No	Semester	Title	Credits
MTC102	II	Matrices and Linear Algebra	4 + 2

SYLLABUS

1. System of linear equations [Nicholson, Chapter 1]: Solutions & Elementary Operations: (Linear system of equations, solutions, equivalence of 2 systems, elementary operations on equations, elementary row operations). Gaussian Elimination: (Row /Row reduced echelon forms, Gaussian algorithm, Rank). Homogeneous Equations: (Sufficient condition for the existence of non-trivial solution). **[6 hours]**

2.Matrix Algebra[Nicholson, Chapter 2]: Matrix Addition, Scalar multiplication, Transposition: (Definition, properties, symmetric matrix). Matrix Multiplication:(Definition, properties, block multiplication). Matrix Inverses: (Definition, uniqueness, properties, Matrix inversion algorithm(row reduction)). Elementary Matrices:(Definition, Properties,theorems).**[3 hours]**

3.Determinants [Nicholson, Chapter 3]: The Laplace Expansion: (Determinant, properties, upper/ lower triangular matrices). Determinant & Matrix inverses (Product theorem & other related theorems, orthogonal matrices, minors, co-factors, adjoint formula for , Cramer's rule)**[3 hours]**

4.Vector Spaces: Definition and examples, Vector subspaces, Basis and Dimension of Vector Spaces. **[6 hours]**

5.Lines and Quotient Spaces: Definition of a line, Affine spaces, Quotient Spaces. **[6 hours]**

6.Linear Transformations: Linear Transformation, Representation of linear maps by matrices, Kernel and Image of a Linear Transformation, Linear Isomorphism, Geometric ideas and some loose ends, Some special Linear Transformations. **[9 hours]**

7.Inner Product Spaces: Inner Product Spaces, The Euclidean plane and the dot product, General Inner Product Spaces, Orthogonality, Some geometric applications, Orthogonal projection onto a line, Orthonormal basis, Orthogonal complements and projections, Linear Functionals and Hyperplanes, Orthogonal Transformations, Coordinates associated with an Orthonormal Basis, Reflections and Orthogonal Maps of the Plane. **[9 hours]**

8.Diagonalization: Rotation of axes of conic, Eigenvalues and eigenvectors, Cayley-Hamilton theorem, Diagonalisation of symmetric matrices.**[9 hours]**

9.Review Problems: Linear equations, Linear dependence, Basis and Dimension, Linear Transformations, Euclidean Spaces, Problems in Linear Geometry, Miscellaneous problems. **[9 hours]**

Learning Objectives:

- To study matrix algebra and use it to solve system of linear equations.
- To study vector spaces and Linear transformations.
- To relate a linear transformation with a matrix.
- To study eigen values and eigen vectors of a matrix and diagonalization.
- To study inner product spaces.

Course Outcomes:

After completion of this course, a student should be able to:

- Solve system of equation of equations using matrices.

- Determine eigen values and eigen vectors and diagonalize a matrix.
- Find a linear transformation associated with a matrix and vice versa.
- Check whether a given vector space is an inner product space.
- Orthonormalize a basis for a vector space.

Paper No	Semester	Title	Credits
MTG101	I	Probability ans Statistics	3 + 2

SYLLABUS

1. **Introduction- Meaning and Scope**: Definition of Statistics, Importance and scope of Statistics, Limitations of Statistics, Distrust of Statistics. **(2 hours)**

2. **Correlation Analysis**: Introduction. Karl Pearson‟s coefficient of Correlation, Rank correlation method. **(10 hours)**

3. **Theory of Probability**: Introduction, Mathematical probability, Statistical probability, Axiomatic probability, Addition theorem of probability.(Proof omitted), Multiplication theorem of probability. Pair wise and mutual independence, Inverse probability – Baye‟s theorem. **(6 hours)**

4. **Random Variables**: Probability Distributions and Mathematical Expectation: Random variable, Probability distribution of a Discrete Random Variable, Probability distribution of a Continuous Random Variable, Mathematical Expectations. **(3 hours)**

5. **Theoretical Distributions**: Binomial distribution, Poisson Distribution, Normal Distribution.

(5 hours)

6. **Testing of Hypothesis**: Interval Estimation, Testing of Hypothesis. **(3 hours)**

7. Large sample tests: Introduction, Sampling of Attributes, Sampling of Variables. **(4 hours)**

8. **Parametric tests**: Student‟s „t‟ distribution, ANOVA, Post-hoc analysis. **(10 hours)**

9. Non-Parametric tests: Chi Square test, Mann-Whitney test, Kruskalwalli‟s test. **(7hours)**

Learning Objectives:

To study the importance, limitations and distrust of statistics.

- To study correlation analysis.
- To study the theory of probability and theoretical probability distributions.
- To study the methods of testing of hypothesis and large sample tests.
- To study chi square Mann Whitney and Kruskal's test of hypothesis.

Course Outcomes:

After completion of this course, a student should be able to:

- Correlate and perform analysis.
- Find measures of central tendency and dispersion.
- Use testing of hypothesis using t test, chi square test and Anova.
- Use Mann Whitney test and kruskal's test.
- use large sample test.

Paper No	Semester	Title	Credits
MTG102	II	Numerical Computations	3 + 2

SYLLABUS:

1. **Elementary Error Analysis:** Introduction. Numbers: Exact and Approximate. Significant digits. Errors: Absolute, Relative and Percentage error. Examples

2. **Calculus of finite differences:**Operator . Difference tables, Properties of . Fundamental theorem of difference calculus. Expression of any value of a function in terms of leading term and leading differences of a difference table. Method of separation of symbols.

3. **Interpolation:** Newton's forward and backward interpolation formulae. Lagrange interpolation formula. Newton's divided difference formula, Examples based on above formulae.

4. **Numerical Differentiation and Integration:** Differentiation formulae for equidistant arguments. Examples. General quadrature formula for equidistance ordinates (Newton-Cotes Formula or Gauss Legendre quadrature formulae.). Trapezoidal rule and its geometrical interpretation. Simpson's one third rule, Simpson's three eight rule. Weddles's rule (only statements).

5. **Solution of Algebraic and Transcendental Equations:** Introduction, Method of Bisection, Regular falsi Method, Newton Raphson Method and their computation schemes. Special case of Newton Raphson method like finding qth root of a positive real number 'd' and finding reciprocal of positive real number 'd' without using division.

6. **Approximations:** The least square polynomial approximation method (Linear, quadratic, Exponential)

Learning Objectives:

- To study the iterative procedures to solve transcendental equations to interpolate, integrate and differentiate.

Course Outcomes:

After completion of this course, a student should be able to:

- Solve numerically any transcendental equation using Bisection method, Regula Falsi method, Newton Raphsons to desired accuracy level.

- To interpolate a function by Using Newton Forward/Backward Interpolations and Lagranges interpolation formula.

- perform numerical differentiation using Newton cotes formula.
- To perform numerical Integration using Trapezoidal, Simpsons and Weddels rule.
- To approximate function by using methods of Least Squares.

Paper No	Semester	Title	Credits
MTC103	III	Ordinary differential Equations and Discrete Maths	4 + 2

SYLLABUS

1. FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS:-

Review of Basic concepts such as order, degree, formation, solution and their types of differential equations. First order first degree differential equation and initial value problem. Method of separation of variables. Homogeneous and Non - homogeneous differential equation. First order linear differential equations. Bernoulli‟s differential equation. Exact and Non – exact differential equations. Condition for exactness. Integrating factors and rules to find integrating factors. Clairaut‟s differential equation and differential equations reducible to Clairaut‟s form. Ricatti‟s differential equation. Applications of first order differential equations. Modeling with differential equations.

(8 Hours)

2. SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS:-

General form of second order linear differential equation and its classification. Existence and Uniqueness theorem for solution of second order linear differential (Only statement). Second order homogeneous linear differential equation and its properties. Wronskian of solutions of homogeneous linear differential equation and its properties. Linear dependence and independence of solutions of homogeneous differential equation. Complementary function. Use of known solution to find second linearly independent solution of homogeneous differential equation. Homogeneous linear differential equations with constant coefficients and with variable coefficients. Method of undetermined coefficients. Method of variation of parameters. Applications of second order linear differential equations. **(10 Hours)**

3. D – OPERATORS:-

D – Operator method to solve n_{th} order homogeneous linear differential equation with constant coefficients. Properties of D – Operator. Inverse D – operator and it properties. Inverse D – operator method to solve n_{th} order Non - homogeneous linear differential equation with constant coefficients **f(D) = R(x)**, where **R(x) =** $\mathbf{e_{ax}}$**, cosax, sin ax**, polynomial in „**x**‟ and their products. **(8 Hours)**

4. SYSTEM OF $\mathbf{1_{ST}}$ **ORDER DIFFERENTIAL EQUATIONS:-**

Conversion of n_{th} order differential equation to first order system of differential equations. Existence and uniqueness of solution (statement only). “ 22 ” homogeneous linear first order system of differential equations and their solution. Wronskian of “ 22 ” homogeneous linear first order system of differential equations and its properties. Linear dependence and independence of solutions of “ 2 2 ” homogeneous linear first order system of differential equations. Matrix method to solve “ 22 ” homogeneous linear first order system of differential equations with constant coefficients. Method of solving “ 22 ” Non - homogeneous linear first order system of differential equations with constant coefficients. **(10 Hours)**

5. GRAPH THEORY:-

Introduction. Basic terminology. Types of Graphs. Multigraphs and Weighted graphs. Isomorphism of graphs. Paths and circuits. Shortest path in weighted graphs.

Eulerian paths and circuits. Hamiltonian paths and circuits. Factors of graphs. planar graphs. **(12 Hours)**

6. TREES AND CUT-SETS:-

Trees. Rooted trees. Path lengths in rooted trees. Prefix codes. Binary search trees. Spanning trees and cut- sets. Minimum spanning tree. Kruskal"s algorithm. Prim"s algorithm. Transport network.

Learning Objectives:

- To classify and study the methods of solutions of various types of first and second order differential equations.
- To study the applications of O.D.E and modelling with differential equations.
- To study conversion of n^{th} order differential equationto a system of first order differential equations.
- To understand the concept of graph theory, basic concept of eulerian path and circuits and Hamiltonian paths and circuits.
- To find spanning trees and find the minimal spanning trees.

Course Outcomes:

After completion of this course, a student should be able to:

- Solve first and second order differential equations with constant coefficients.
- Identify the type of difffferntial equation and use method of D operators to various cases of differential equations.
- Find shortest path in weighted graphs.
- identify Eulerian and Hamiltonian paths and circuits.
- Determine minimum spanning tree using Kruskals / Prims algorithm.

Paper No	Semester	Title	Credits
MTC104	IV	Analysis and Operations Research	4 + 2

SYLLABUS

1. Infinte Series [Ajitkumar, Chapter 5]:

Convergence of infnite series, absolute convergence, Conditional convergence, Geometric series, Cauchy criterion for convergence, Algebra of convergent series, Comparision test, Convergence of Harmonic P-series, D'Alembert ratio test,Cauchy nth root test,Leibniz test or alternating series test**.** **[10 hours]**

2. Riemann Integration [Ajitkumar, Chapter 6]:

DarbouxIntegrability, Criterion for integrability, Properties of integrabilities. First fundamental theorem of calculus, Second fundamental theorem of calculus, integration by parts, Mean value theorems for integrals, First mean value theorem for integrals, Second mean value theorem I, Second mean value theorem II, Riemann original definition**.**

[20 hours]

3. Sequences and Series of functions[Ajitkumar, chapter 7]:

Pointwise convergence of sequence of functions and examples, Uniform convergence of sequence of functions and examples, Mn-Test,Cauchy Criterion for uniform convergence, Consequences of Uniform convergence, Continuity of limit function, Series of functions, Absolute convergence, Cauchy Criterion for uniform convergence of a series, Weierstrass M-test, Weierstrass Approximation Theorem. **[10 hours]**

4. Operations Research

Fundamentals: Linear Programming problems, Convex sets ,Extreme points of Convex sets, Convex Polyhedron ,hyperplanes, Graphical Method, Simplex Method, Theorems on simplex method ,Big-M method, Two phase method, Unrestricted variables, Duality and solution using duality, Theorems on Duality, Dual Simplex method, Post Optimal Analysis (Discrete changes in cost and requirement vector) Transportation Problems, North west corner method, Vogel's approximation method, Modi Method, Assignment Problems, Hungrian Method, Basics of Inventory control, Inventory model with No shortages and Instantaneous production, Inventory model with Shortages allowed and Instantaneous production. Basics of Queueing theory, Queueing Model (M/M/1):(1/FIFO),

Queueing Model (M/M/1):(N/FIFO).

Learning Objectives:

- To study the concept of infinite series, their convergence as a limit of sequence of partial sums and various tests for convergence of a series.
- To study the concept of Riemann integration as an area under the curve, concept of upper integral and lower integral, criteria for Riemann integrability and proofs of properties of integrations.
- To study the mean value theorem, the concept of antiderivative and relation between integrals and derivatives.
- To study the concept of sequences and series of functions, their pointwise and uniform convergence.
- To study the various methods of solving linear proframming problems, transportation problems, inventory controls and queueing systems.

Course Outcomes:

After completion of this course, a student should be able to:

- Apply a suitable test and discuss the convergence of a series.
- Check whether a given bouded function on a closed and bounded interval is Riemann integrable or not.
- Discuss the pointwise and uniform convergence of a sequence of functions using basic definition and properties.
- Discuss uniform convergence of a series of functions using limit of partial sum and M test.
- Solve a L.P.P using simplex method, transportation problems using Modi method, assignment problem problems using Hungarian method, economic order policy for economic control and problems in queuing models.

Paper No	Semester	Title	Credits
MTS101	III	Statistical Methods	3 + 2

SYLLABUS

1. **Introduction- Meaning and Scope**: Definition of Statistics, Importance and scope of Statistics, Limitations of Statistics, Distrust of Statistics. **(2 hours)**

2. **Correlation and Regression Analysis**: Introduction. Karl Pearson"s coefficient of Correlation, Rank correlation method. Regression Analysis. **(10 hours)**

3. **Theory of Probability**: Introduction, Mathematical probability, Statistical probability, Axiomatic probability, Addition theorem of probability.(Proof omitted), Multiplication theorem of probability. Pair wise and mutual independence, Inverse probability – Baye"s theorem. **(6 hours)**

4. **Random Variables**: Probability Distributions and Mathematical Expectation: Random variable, Probability distribution of a Discrete Random Variable, Probability distribution of a Continuous Random Variable, Mathematical Expectations. **(3 hours)**

5. **Theoretical Distributions**: Binomial distribution, Poisson Distribution, Normal Distribution.

(5 hours)

6. **Testing of Hypothesis**: Interval Estimation, Testing of Hypothesis. **(3 hours)**

7. Large sample tests: Introduction, Sampling of Attributes, Sampling of Variables. **(4 hours)**

8. **Parametric tests**: Student"s „t" distribution, ANOVA, Post-hoc analysis. **(10 hours)**

9. Non-Parametric tests: Chi Square test, Mann-Whitney test, Kruskalwalli"s test. **(7hours)**

Learning Objectives:

- To study the importance, limitations and distrust of statistics.
- To study correlation and regression analysis.
- To study the theory of probability and theoretical probability distributions.
- To study the methods of testing of hypothesis and large sample tests.
- To study chi square Mann Whitney and Kruskal’s test of hypothesis.

Course Outcomes:

After completion of this course, a student should be able to:

- Correlate and perform regression analysis.
- Find measures of central tendency and dispersion.
- Use testing of hypothesis using t test, chi square test and Annova.
- Use Mann Whitney test andkruskal’s test.
- use large sample tes

Paper No	Semester	Title	Credits
MTS102	IV	Analytical Geometry	3 + 2

SYLLABUS

1. **Metric Properties on the Plane**. (3 hours)

2. **Straight Lines in the Plane**. (3 hours)

3. **Circles in Plane**. (3 hours)

4. **Conics in the Plane and its plane sections**. (12 hours)

5. **Classification of Conics**. (5 hours)

6. **Polar Co-ordinate System**. (3hours)

7. **Co-ordinates in 3-space**. (3 hours)

8. **Plane in 3-space**. (4 hours)

9. **Lines in 3-space**. (3 hours)

10. **Transformation of Co-ordinates**. (4 hours)

11. **Sphere**. (4 hours)

12. **Cones**. (4 hours)

13. **Cylinder**. (4 hours)

14. **The Conicoid**. (5 hours)

Learning Objectives:

- To study locus of a line, circle, conics in planes and plane sections.
- To study coordinate system and transformation of coordinates.
- To study sphere, cone, cylinder and conicoids.
- To study lines and planes in three space.

Course Outcomes:

After completion of this course, a student should be able to:

- Solve problems in analytical geometry.
- classify conics.
- Verify properties of lines, circles, parabola , ellipse etc.
- Transform coordinates.

Paper No	Semester	Title	Credits
MTC105	V	Algebra	6

SYLLABUS

1. Groups definition and elementary properties; Finite group and subgroups; Examples; Cyclic groups; Properties of cyclic groups; Classification of subgroups of cyclic groups.

2. Permutation groups; Cycle notation; Properties of permutations. Isomorphisms: Definitions and examples; Cayley's Theorem; Properties of isomorphisms; Automorphism.
(20 hrs)

3. Cosets; Properties of cosets; Lagrange's Theorem and consequences; An application of cosets to permutation group.

4. Definition and examples of external direct product; Properties of external direct product; The group of units modulo n as an external direct product.

5. Normal subgroups and factor groups; Application of factor groups; Internal direct product. Defination and examples of group homomorphisms; Properties of homomorphisms; First Isomorphism Theorem.

6. Fundamental Theorem of Finite Abelian Groups; Isomorphism classes of abelian groups; Proof of Fundamental Theorem.

7. Rings; Properties of rings; Subrings; Integral domains; Examples of integral domains; Fields; Charecteristic of a ring.

8. Ideals and Factor rings; Prime ideals; maximal ideals; Ring homomorphisms; Properties of ring homomorphisms; Field of quotients.

9. Polynomial rings; The Division Algorithm and consequences.

Learning Objectives:

- To study group theory and various examples of groups. To study properties of groups.
- To study mappings on groups.
- To study the Fundamental Theorem of Finite Abelian Group

- To study rings and their properties.
- To study Division algorithm.

Course Outcomes:

After completion of this course, a student should be able to:

- Perform standard group computations and permutations on a finite set.
- Give examples of Groups, Rings and Fields.
- Apply lagranges theorem to study subgroups of a finite group.
- Understand the notion of homomorphisms and issomorphisms of groups and rings.

Paper No	Semester	Title	Credits
MTC106	V	Analysis II	6

SYLLABUS

1. Improper Integrals: Improper Integrals of type I; Cauchy's general principle of convergence for Improper integrals of type I; Comparison test for improper integrals of type I; Comparison test in limit form for improper integrals of type I; p - test for improper integrals of type I; Improper Integrals of type II; Cauchy's general principle of convergence for Improper integrals of type II; Comparison test for improper integrals of type II; Comparison test in limit form for improper integrals of type II; p - test for improper integrals of type II; Improper Integrals of type III.

2. Beta and Gamma Functions: Definitions of Beta and Gamma Functions and their convergence. Properties of Beta and Gamma functions. Relation between beta and Gamma functions. Legendre's duplication formula.

3. Power series in IR: Definition and examples. Radius and interval of convergence, Uniform convergence and absolute convergence, Term by term differentiation and integration of power series in IR. Power series definitions of Exponential, Logarithmic and trigonometric functions, their properties. Weierstrass' polynomial approximation theorem.

4. Inner product spaces: Usual integral inner product on C[a, b] and its properties. Norm induced by usual integral inner product. Orthogonal and orthonormal sequences of functions in C[a, b] with usual integral inner product. Complete orthogonal and orthonormal set in C[a, b] with respect to usual integral inner product. Bessel's inequality and Parsevel's identity set in C[a, b] with respect to usual integral inner product.

5. Fourier series: Fourier series of real functions on $(-\pi, \pi)$ and $(0, \pi)$. Fourier coefficients; properties of Fourier coefficients; the Fourier series of a function relative to an orthonormal system. Bessel's inequality. Trigonometric Fourier series, Fourier series of odd & even function. Integration & differentiation of Fourier series at a point. Fourier theorem. Fourier Series of real functions on (c, c+2l). Riemann-Lebesgue Lemma. Parsevel's identity.

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Learning Objectives:

- To study improper integrals.
- To study special improper integralsi.e. Beta and gamma functions.
- To study Real power series and their convergence.

- To study fourier series.
- To study inner product spaces on C[a,b] and its properties.

Course Outcomes

After completion of this course, a student should be able to:

- Understand and classify the improper integrals.
- evaluate integrals
- discuss the convergence and divergence of real power series.
- discuss the convergence and divergence of fourier series.
- obtain aorthonorma; basis in C[a,b] with respect to inner product.

Paper No	Semester	Title	Credits
MTC107	V	Calculus of 2 and 3 Variables	6

SYLLABUS

Differential Calculus.

Review of vectors in Plane and space. Vector products and their properties. n- dimensional Euclidean space. Curves in the plane and space.

Functions from IR^n to R (scalar fields) and functions from IR^2 to IR^3 (vector fields), limits and continuity of functions, basic results on limits and continuity of sum, difference, scalar multiples of vector fields, continuity and components of a vector field. Partial derivatives and continuity. Differentiability. Derivative Matrix and tangent planes. The Chain rule. Gradients and directional derivatives. Implicit differentiation.

Higher order partial derivatives, equality of mixed derivatives. Taylors theorem. Critical points and extrema. . Second derivative test. Constrained extrema and Lagrange's multipliers

Applications. Acceleration. Arc length. Vector fields. Divergence and Curl .

Integral Calculus

Volume and Cavalier's Principle. Double integral over a Rectangle, over a region. Triple integrals. Change of variables, cylindrical and spherical coordinates. Applications. Average value, center of mass, moments of inertia.

Integrals over curves and surfaces. Line integrals. parameterized surfaces. Area of a surface. Surface integrals. Green's theorem. Stokes' Theorem, Gauss' theorem. Path independence. Fundamental theorem of Calculus.

Learning Objective:

- To present the fundamental concepts of multivariable calculas and to develop students understanding and skills for its applications to science and engineering.
- To study curves in planes and spaces.
- To study scalar field and vector fields.
- To study line integral, double integrals, surface integrals and volume integrals.

- To study gradient, divergence and curl and its applications.
- To study higher derivatives of functions of two and three variables and ectremisation.

Course Outcomes:

After completion of this course, a student should be able to:

- Understand vectors to perform geometrical calculations in three dimensions.
- Calculate and interpret derivatives upto three dimensions.
- Integrate functions of several variables over curves and surfaces.
- Use greens theorem , Gauss Divergence Theorem and Stokes theorem to compute varios integrals such as Line, surface and Volume integrals.

Paper No	Semester	Title	Credits
MTE101	V	Foundations of Mathematics	4

SYLLABUS

1. **Statements and Logic**: Statements; Statements with quantifiers; Compound statements; Implications; Proofs in Mathematics.

2. **Sets**: Sets; Operations on sets; Family of sets; Power sets;

Cartesian product of sets.

3. **Functions**: Basic definitions; one-one, onto functions and bijections; Composition of functions; Inverse of a function; Image of subsets under functions; Inverse image of subsets under functions.

4. **Relations**: Relation on sets; Types of relations; Equivelence relations; Equivelence classes and partitions of sets.

5. **Induction Principles**: The induction Principle; The Strong Induction Principle; The Well-Ordering Principle; Equivalence of the three principles.

6. **Countability of sets**: Sets with same cardinality; Finite sets; Countable sets; Comparing cardinality.

7. **Order Relation**: Partial and total orders; Chains, bounds and maximal elements; Axiom of choice and its equivalents.

Learning Objectives:

- To learn basic set theory.
- To create a strong foundation to study higher level Mathematics.
- To understand the notion of functions and its various properties.
- understand the notion of Countable sets.
- To learn order relations.

Course Outcomes

After completion of this course, a student should be able to:

- Analyse mathematical statements and logic.
- Check for equivalence relations.
- apply Induction principles to solve mathematical problems.
- Compute and compare cardinality of sets.

Paper No	Semester	Title	Credits
MTE102	V	Combinatorics	4

SYLLABUS

1 **Basic Methods:**

Basic Pigeon-hole principle, generalized Pigeon-hole principle, methods of mathematical induction – weak induction and strong induction.

2 Elementary Counting Problems:

Permutations, Strings over finite alphabet, Choice problems.

3 The Binomial Theorem:

Binomial theorem, Multinomial theorem, Ehen exponent is not a positive integer.

4 Partitions:

Compositions, Set partitions, Integer partitions.

5 Cycles in Permutations:

Cycles in permutations, Permutations with restricted cycle structure.

6 The Sieve:

Enumerating the elements of intersecting sets, applications of the sieve formula.

7 Generating Functions:

Ordinary generating functions – Recurrence relations and generating functions, Products of generating functions, Compositions of generating functions.

Exponential generating functions – Recurrence relations and exponential generating functions, Products of exponential generating functions, Compositions of exponential generating functions.

Learning Objectives:

- To study the basic methods of counting such as pigeonhole principle.
- To study various enumeration techniques which can be applied in diverse fields of mathematics.

- To study binomial theorem.
- To study generating functions.

Course Outcomes

After completion of this course, a student should be able to:

- apply Combinatorics in various fields of Mathematics.
- deal with problems which involves counting and which required several enumerative techniques.
- apply Induction principles to solve mathematical problems.
- solve recurrence relations.

Paper No	Semester	Title	Credits
MTE102	VI	MTC108 Differential Equations II	6

SYLLABUS

1. **Review of First and Second order ordinary differential equations:**

Basic concepts. First order ordinary differential equations with constant coefficients. Homogeneous and non homogeneous equations. Exact and non exact differential equations. Integrating factors. Second order differential equations with constant coefficients. Complementary function and particular solution. Use of known solution to find linearly independent second solution.Method of variation of parameters. Equations with variable coefficients. Method of undetermined coefficients.

2. **Power Series Solutions of Some Linear Equations:**

Homogeneous equations with analytic coefficients. Legendre equation, Justification of power series method, Introduction to linear equations with Regular singular points, Euler equation, example and general case of second order equations with regular singular points, A convergence proof, Exceptional cases, Bessel equation, Regular singular points at infinity. Properties of Legendre Polynomials and Bessel's function. Generating function.

3. **Laplace Transforms:**

Laplace transforms of various functions, General properties of Laplace transforms, Inverse Laplace transforms, Convolution theorem, Application of Laplace transforms to solve differential equations.

4. **Numerical Methods of Solving Differential Equations:**

Picard's method, Euler's method, Modified Euler's method, Runge-Kutta method, Milne's method, Adams-Bashforth-Moulton method.

Learning Objectives:

- To study various methods of solving Ordinary differential equations.
- To undesratnd singular points.
- To learn power series method to solve differential equations.
- To learn Laplace transforms its application to solve differential equations.

- To learn numerical methods to solve ODE.

Course Outcomes

After completion of this course, a student should be able to:

- Solve ODE of first and second order.
- Solve ODE using power series method.
- Solve IVPs using laplace transforms.
- Solve IVPs using numerical methods like rungakutta methods and Milnes Method.

Paper No	Semester	Title	Credits
MTC109	VI	Complex Analysis	6

SYLLABUS

I. Complex Numbers:

Sums and products, Algebraic properties, Vectors and moduli, Complex conjugates, Exponential form, Arguments of products and quotients, Roots of complex numbers, Regions in the complex plane.

II. Analytic Functions:

Functions of complex variable, Limits, Theorems on limits, Continuity, Derivatives, Differentiation formulas, Cauchy-Riemann equations, Sufficient condition for Differentiability, Polar coordinates, Analytic functions, Harmonic functions.

III. **Elementary Functions:**

Exponential function, Logarithmic function, Branches and Derivatives of Logarithms, Identities involving logarithms, Complex exponents, Trigonometric functions, Hyperbolic functions, Inverse trigonometric and hyperbolic functions.

IV. **Integrals:**

Derivatives of functions, Definite integrals of functions, Contours, Contour integrals, Contour integrals of functions with branch cuts, Upper bounds for moduli of contour integrals, Antiderivatives, Cauchy-Goursat theorem (without proof), Simply and Multiply connected domains, Cauchy integral formula and extension of Cauchy integral formula, Liouville's theorem, Fundamental theorem of algebra, Maximum modulus principle.

V. **Series:**

Convergence of sequences and series, Taylor series, Taylor's theorem, Laurent series, Laurent's theorem.

VI. Residues and Poles:

Isolated singular points, Residues, Cauchy Residue theorem, Residue at infinity, The three types of Isolated singular points, Residues at poles, Zeros of analytic functions, Zeros and Poles, Behavior of functions near isolated singular points, evaluation of improper integrals, Argument principle and Roche's theorem.

VII. **Mappings by Elementary functions:** **[**

Linear transformations, Transformation w=1/z, Mappings by 1/z, Mobius transformation.

Learning Objectives:

- To introduce complex numbers and their properties.
- To study analytic functions.
- To study branches of elementary functions.
- To study contour integrals.
- To study Cauchys Integral Formula and its applications.
- To study Taylors and Laurent series of complex functions..
- To study residues and Poles of complex functions.
- To study bilinear maps..

Course Outcomes

After completion of this course, a student should be able to:

- perform basic operations and Geometric interpretation of complex numbers.
- Identify analytic functions
- evaluate contour integrals.
- apply Cauchy Integral formula.
- to express functions in terms of Lauratnt series. residues and poles of complex functions and apply it to evaluate contour integrals.
- analyse bilinear maps.

Paper No	Semester	Title	Credits
MTC110	VI	Metric Spaces	6

SYLLABUS

1. INTRODUCTORY CONCEPTS IN METRIC SPACES:-

(20 Hours)

Definition and Examples of Metric Spaces, Open Balls and Closed Balls, Hausdorff Property, Interior Point and Interior of a Set, Open Sets and their properties, Closed Sets and their properties, Limit Points and Isolated Points, Derived Set and its properties, Closure of a Set and its properties, Boundary Points, Distance between Sets, Diameter of a Set, Subspace of Metric Space and its properties, Boundedness in a Metric Space.

2. COMPLETENESS IN METRIC SPACES:-

(10 Hours)

Sequence in a metric Space, Convergence of a Sequence in a Metric Space, Cauchy Sequence in a Metric Space, Complete Metric Spaces, Cantor's Intersection Theorem, Dense Sets and Nowhere Dense Sets.

3. CONTINUOUS FUNCTIONS ON METRIC SPACES:-

(20 Hours)

Continuity of a Function at a Point using **-** definition, Sequential Continuity, Continuity of Functions using Open Sets and Closed Sets, Continuity of Functions using Closure of a Set, Contraction map and its properties, Fixed Points, Picard's Fixed Point Theorem, Picard's Existence and Uniqueness Theorem for First Order Initial Value Problem, Application to solve First Order Initial Value Problem.

4. COMPACTNESS IN METRIC SPACES:-

(20 Hours)

Compact Metric Spaces and Compact Sets, Examples of Compact Metric Spaces and Compact Sets, Properties of Compact Metric Spaces and Compact Sets, Sequential Compactness, Bolzano – Weierstrass Property, Heine – Borel Theorem, Totally Boundedness, Equivalence of Compactness and Sequential Compactness, Lebesgue Covering Lemma, Compactness and Finite Intersection Property, Continuous Functions and Compactness.

5. CONNECTEDNESS IN METRIC SPACES:-

(20 Hours)

Separated Sets, Connected Metric Spaces and Connected Sets, Properties of Connected Metric Spaces and Connected Sets, Connected Subsets of IR, Connectedness and Continuous Functions, Intermediate value Theorem.

Learning Objectives:

- To introduce students toconcept of metric spaces, its aubspaces , open and closed balls and continuity of functiona.
- To study complete metric spaces.
- To study continous functions on metric spaces.
- To understand Picards Fixed point theorem for the existence and Uniqueness of solutions to first order IVPs.
- To study Compact metric spaces.
- To study connected metric spaces.

Course Outcomes

After completion of this course, a student should be able to:

- Identify metric spaces.
- Check the convergence of a given sequence in a metric space.
- Identify complete metric spaces.
- Check the continuity of functions on metric spaces using open sets and convergence of sequences.
- Identify compact metric spaces.
- Check connectedness of metric spaces.

Paper No	Semester	Title	Credits
MTE103	VI	Number Theory	4

SYLLABUS\

1. **DIVISIBILITY THEORY IN INTEGERS:-**
(12 Hours)
Divisibility in and its properties, Proper and Improper Divisors, Division Algorithm, Greatest Common Divisor(gcd) and its properties, Least Common Multiple(lcm) and its properties, Euclidean Algorithm to find gcd of two integers, Prime integers, Composite integers and Relatively Prime or Co-prime integers, Euclid's Lemma, The Linear Diophantine equation **ax + by = c**, The Fundamental Theorem of Arithmetic, The Sieve of Eratosthenes.

2. THEHEORY OF CONGRUENCES:- (10 Hours)
Congruence Modulo 'n' Relation and its properties, Linear Congruence in one variable and its solution in , Congruent and Incongruent solutions of Linear Congruence. System of Linear Congruence in one variable and Chinese Remainder Theorem, System of Linear Congruence in two variables, Fermat's Theorem and Wilson's Theorem.

3. NUMBER – THEORETIC FUNCTIONS:-
(15 Hours)

The Functions and and their properties, Multiplicative Functions.
The M bius Function and its Properties, Multiplicative property of M bius Function , . The M bius Inversion Formula, The Greatest Integer Function and its properties, Euler's Phi – Function and its properties. Euler's Theorem.

4. SOME NON-LINEAR DIOPHANTINE EQUATIONS:-
(08 Hours)
Pythagorean triple**,** Primitive Pythagorean triple, Non- Linear Diophantine Equation $\mathbf{x^2 + y^2 = z^2}$, Fermat's Last Theorem.

Learning Objectives:

- To introduce the theory of numbers and basic concepts related to numbers.
- To study Division algorithm.
- To study different Arithnetic functions.

- To study congruences.
- To study Diophantine equations.

Course Outcomes

After completion of this course, a student should be able to:

- apply Division algorithm.
- Solve linear congruences and system of linear congruences.
- solve Diophantine equations.
- apply Fermats theorem.

Paper No	Semester	Title	Credits
MTE104	VI	Operations Research II	4

SYLLABUS

1. **Project Management**

   Planning, Scheduling and controlling of a project. Techniques of analysing. Methods of planning and programming. Development of bar charts. Shortcomings and remedial measures. Milestone Charts

2. **Elements of Network**

   Event, activity, dummy. Rules of Network, Numbering of events, Cycles. Planning for network construction. Work breakdown structures.

3. **Project Evaluation & Review Technique (PERT)**

   PERT time estimates T_E, $T_{L.}$ Network analysis. Probability of meeting schedule time.

4. **Critical Path Method (CPM)**

   CPM process and network. Time estimates, Float. Critical activities and path. Project crashing

5. **Dynamic Programming**

   Dynamic Programming: Recursive nature of dynamic programming Forward and Backward Recursion

6. Integer Linear Programming (ILP)

Algorithms: Branch and Bound; Cutting Plane; Heuristic. Examples. Computational considerations in ILP. Travelling salesman problem.

Learning Objectives:

- To study project management.
- To study elements of network PERT and CPM.

- To study dynamic programming.
- To study ILP.
- To study basic game theory.

Course Outcomes

After completion of this course, a student should be able to:

- handle project scheduling by CPM and PERT techniques..
- solve dynamic programming problems.
- Solve travelling salesmen problem.
- Solve simple game problems.