Syllabus for Uchcha Madhyamic Paper II STET 2023

UNIT I Subject – Mathematics 100 marks

1. **Algebra**

Polar representation of complex numbers, nth roots of unity, Complex argument, De-Moivre's theorem for integer and rational indices and its applications, Hyperbolic functions, Summation of series, Gregory series.

Fundamental theorem of algebra, Relation between roots and coefficients of a polynomial equation, Transformation of equation, Descartes rule of signs, Solution of Cubic equation (Cardon's method) and bi-quadratic equation (Euler's method).

Cartesian product of sets, Equivalence relations, Functions, Composition of functions, Invertible functions, Cardinality of a set, Countable and Uncountable sets, Cantor's theorem, Well-ordering principle, Division algorithm, Euclidean algorithm, Fundamental Theorem of Arithmetic, Modular arithmetic and basic properties of congruences, Principle of mathematical induction.

2. **Number Theory:**

Division algorithm, Euclidean algorithm and Greatest common Divisor (GCD or HCF), Prime and Composite numbers, Fundamental theorem of arithmetic, Co-primes, Divisor of composite numbers.

Linear Diophantine equation, Prime counting function, Prime number theorem, Fermat theorem. The order of an integer modulo n, Primitive roots for primes, Composite numbers having primitive roots; Definition of quadratic residue of an odd prime, and Euler's criterion.

Congruence relation and its properties, Linear congruence and Chinese remainder theorem, Fermat's little theorem, Wilson's theorem.

Number theoretic functions for sum and number of divisors, Multiplicative function, The Mobius inversion formula, The greatest integer function. Euler's phi-function and properties, Euler's theorem.

3. **Calculus, Analytical Geometry of two and three dimensions:**

Successive differentiation and Leibnitz's theorem, Expansion of functions, Tangent and Normal, Partial differentiation and Euler's theorem, Concavity and inflection points, Asymptotes, Curve tracing in Cartesian coordinates, Tracing in polar coordinates of standard curves, Curvature, L'Hospital's rule.

Evaluation of definite integrals, Reduction formulae, Volumes by Slicing, Disk and Washer methods, Volumes by cylindrical shells, parametric equations, rectification and quadrature, Volume and surface area of solids of revolution, Multiple integrals and change of order of integration, improper integrals, Beta and Gamma functions.

Transformation of rectangular axes, General equations of conic and its reduction to the normal form, Equation of the tangent and normal at a point of the Conic. Sphere, cone, cylinder, Central conicoid, Paraboloids, Plane section of conicoid, Generating lines, Tangent plane and normal to a conicoid.

4. **Real Analysis and Real functions:**

Dedekind theory of real numbers, Algebraic and order properties of R, Archimedean Property, Completeness property of R, Bounded sets, Supremum and Infimum. Neighbourhood of a point in R, Open and closed sets, Limit points and isolated points of a set, Bolzano-Weierstrass theorem for a set.

Sequence and its convergence, Bounded sequence, Limit of a sequence. Limit Theorem, Monotone sequences, Subsequences, Bolzano-Weierstrass theorem for sequences, Limit superior and limit inferior for bounded sequence, Cauchy sequence, Cauchy's general principle of convergence.

Infinite series and their convergence, Cauchy Criterion, Tests for convergence: Comparison test, Ratio Test, Logarithmic ratio test, Cauchy's root test, Alternating series, Leibniz test, Absolute and Conditional convergence. Integral test for series of arbitrary terms, Euler's constant, Dirichlet's and Abel's test for series of arbitrary terms, Riemann and Pringsheim's method for rearrangement of terms of conditionally convergent series, Cauchy's Theorem, Infinite product and its convergence.

Limit, Continuity and Differentiability of a function, Rolle's, Mean- value theorem and its applications, Darboux's theorem, Taylor's theorem with Lagrange form of remainder, Application of Taylor's theorem in error estimation.

Riemann Integral, Riemann integrability of continuous functions, Monotonic function and function having finite number of discontinuities, Fundamental theorem of integral calculus, Mean value theorem. Improper integrals of Type-1, Type-II and mixed type, Convergence of Beta and Gamma functions and their properties.

5. **Ordinary Differential Equations:**

Differential equations and mathematical models, general, particular, explicit, implicit and singular solutions of a differential equation, Exact differential equations and integrating factors, special integrating factors and transformations, separable equations and equations reducible to this form, linear equation and Bernoulli equations. Differential equations of the first order but not of the first degree. Singular solutions, Clairaut's form, Orthogonal Trajectories of family of curves, Total differential equation in three variables, Simultaneous differential equations.

General solution of homogeneous equation of second order, Principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, Method of undetermined coefficients, Method of variation of parameters.

Definition and Linearity of Laplace transform, Existence Theorem, Laplace transform of derivatives and integrals, shifting theorems and inverse Laplace transform, Solution of ordinary differential equation using Laplace transform. Fourier series for odd and even functions, Half range series, other forms of Fourier series.

6. **Partial Differential Equations:**

Partial differential equations - Basic concepts and definitions. Formation of PDE, Mathematical problems. First order equations: classification, construction and geometrical interpretation, Lagrange's and Charpit's method for solving PDE. Method of characteristics for obtaining general solution of quasi linear equations, Canonical forms of first-order linear equations, Method of separation of variables for solving first order partial differential equations.

Partial differential equation of second and higher order, Homogeneous and non-homogeneous equation with constant coefficients, Cauchy problem for second order PDE.
Partial differential equations reducible to equations with constant coefficients, Monge's Methods. Classification of second order linear equations as hyperbolic, parabolic or elliptic, Reduction of second order linear equations to canonical forms, Concept of the wave equation and heat equation.

7. **Abstract Algebra:**

Definition and examples of groups, Elementary properties of groups, Subgroups and examples of subgroups, Centralizer, Normalizer, Centre of a group, Product of two subgroups; Properties of cyclic groups, Classification of subgroups of cyclic groups.
Permutations Groups, Properties of permutations, Even and odd permutations, Properties of Cosets, Lagrange's theorem and consequences including Fermat's Little theorem; Normal subgroups, Quotient groups, Cauchy's theorem for finite abelian groups
Group homomorphisms, Properties of homomorphisms, Group isomorphisms, Cayley's theorem, Properties of isomorphisms, First, Second and Third isomorphism theorems for groups. Automorphism, Inner automorphism, Automorphism groups, Automorphism groups of finite and infinite cyclic groups.
Conjugacy classes, The class equation, p-groups, The Sylow theorems and consequences, Applications of Sylow theorems.

Definition and examples of rings, Properties of rings, Subrings, Integral domains and fields, Characteristic of a ring, Ideal, Ideal generated by a subset of a ring, Quotient rings, Operations on ideals, Prime and maximal ideals.
Ring homomorphisms, Properties of ring homomorphisms, Isomorphism theorems. Characteristics of ring, Field of quotient of an integral domain, Embedding of rings. Polynomial rings, Division algorithm, Principal ideal domains, Euclidean domains, Unique factorization domains.

8. **Linear Algebra:**

Matrices, Operation on Matrices, Matrix algebra, Kinds of matrices, Transpose, Adjoint and Inverse of a matrix, Solution of a system of linear equations by matrix methods, Row reduction and Echelon forms using elementary row operations, Rank of a matrix.
Vector spaces, Subspaces, Algebra of subspaces, Quotient spaces, Linear combination of vectors, Linear span, Linear independence, Basis and dimension, Dimension of subspaces.
Linear transformations, Rank-Nullity theorem, Matrix representation of a linear transformation, Algebra of linear transformation, Eigen values and Eigen vector, Characteristic equation of a matrix and Cayley-Hamilton theorem.
Eigen spaces of a linear operator, Diagonalizability, Invariant subspaces, The minimal polynomial for a linear operator. Inner product spaces and norms, Orthonormal basis, Gram-Schmidt orthogonalization process, Orthogonal complements, Bessel's inequality.
The adjoint of a linear operator, Least squares approximation, Minimal solutions to systems of linear equations, Normal, Self-adjoint, Unitary and orthogonal operators
and their properties.

9. **Multivariate Calculus:**

Functions of several variables, Level curves and surfaces, Limits and continuity, Partial differentiation, Higher order partial derivative, Tangent planes, Total differential and differentiability, Chain rule, Directional derivatives, Gradient, Maximal and normal property of the gradient, Tangent planes and normal lines. Extrema of functions of two variables, Method of Lagrange multipliers, Constrained optimization problems.

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

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

10. Complex Analysis:

Functions of complex variable, Mappings; Mappings by the exponential function, Limits, Theorems on limits, Limits involving the point at infinity, Continuity, Derivatives, Differentiation formulae, Cauchy-Riemann equations, Sufficient conditions for differentiability; Analytic functions and their examples.

Exponential function, Logarithmic function, Branches and derivatives of logarithms, Trigonometric function, Derivatives of functions, Definite integrals of functions, Contours, Contour integrals and its examples, Upper bounds for moduli of contour integrals.

Antiderivatives, Proof of antiderivative theorem, Cauchy-Goursat theorem, Cauchy integral formula; An extension of Cauchy integral formula, Consequences of Cauchy integral formula, Liouville's theorem and the fundamental theorem of algebra.

Convergence of sequences and series, Taylor series and its examples; Laurent series and its examples, Absolute and uniform convergence of power series, Uniqueness of series representations of power series. Isolated singular points, Residues, Cauchy's residue theorem, Residue at infinity, Types of isolated singular points, Residues at poles and its examples.

11. Metric Space:

Metric spaces: Definition and examples, Notion of Open and closed ball, Neighbourhood, Open set, Interior of a set, Limit point of a set, Derived set, Closed set, Closure of a set, Diameter of a set, Dense set, Subspaces.

Sequences in metric spaces, Cauchy sequences, Complete metric space, Cantor's intersection theorem, Baire's category theorem, Contraction mapping, Banach fixed point theorem.

Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity, Homeomorphism. Connectedness, Connected subsets of R, Connectedness and continuous mappings. Compactness, Compactness and boundedness, Continuous functions on compact spaces.

12. Mechanics & Vectors:

Reduction of a system of Co-planar forces, equation of the line of action of the resultant, Virtual work, Principle of virtual work for a system of particles, Forces in three dimensions.

General conditions of equilibrium, Stable and unstable equilibrium, Common catenary, Centre of gravity for different bodies.

Rectilinear motion in a non-resisting and a resisting medium, Harmonic oscillator, damped and free vibrations, elastic strings and springs, vertical and horizontal motion of a particle attached to an elastic string. Motion in a plane, velocities and accelerations in Cartesian, polar and intrinsic Co-ordinates, motion of a projectile in non-resisting and resisting medium, constrained motion in a smooth horizontal and vertical circle, simple pendulum.

Motion of a particle under a central force, differential equation of a central orbit in rectilinear, polar and pedal coordinates, Central orbits, Kepler's laws of motion deduced from Newton's law of Gravitation and vice-versa.

Degrees of freedom, Moments and products of inertia, Principal axes, D'Alembert's Principle. Motion about a fixed axis, Compound pendulum, Motion of a rigid body in two dimensions under finite and impulsive forces, Conservation of momentum and energy.

Scalar triple product and vector triple product, Product of four vectors, Introduction to vector functions, Operations with vector-valued functions, Limits and continuity of vector functions, Differentiation and integration of vector functions, Gradient of a scalar and Divergence and Curl of a vector function in Cartesian coordinate.

13. Numerical Methods:

Errors: Relative, Absolute, round off, Truncation, Finding roots of Transcendental and Polynomial equations: Bisection method, Secant method, Regula-Falsi method, Newton-Raphson method, Fixed point iteration method, Rate of convergence.

Solution of system of linear algebraic equations: Partial and scaled partial pivoting, LU decomposition and its applications, Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and SOR methods and their convergence analysis.

Finite Central and divided differences, Interpolation, Inverse Interpolation, Numerical differentiation, Numerical Integration: Newton Cotes formula, Trapezoidal rule, Simpson's 1/3rd rule, Simpsons 3/8th rule, Gauss quadrature formula.

Solution of difference equation of the first order, General solution, Linear difference equation with constant co-efficient, Solution of ordinary differential equations one step method: Euler's modified, Picard's, Runge-Kutta methods.

14. Linear Programming Problem:

The Linear Programming Problem: Standard, Canonical and matrix forms, Graphical solution. Hyperplanes, Extreme points, Convex and polyhedral sets. Basic solutions; Basic Feasible Solutions; Reduction of any feasible solution to a basic feasible solution; Correspondence between basic feasible solutions and extreme points.

Simplex Method: Optimal solution, Termination criteria for optimal solution of the Linear Programming Problem, Unique and alternate optimal solutions, Unboundedness; Simplex Algorithm and its Tableau Format; Artificial variables, Two-phase method, Big-M method.

Motivation and Formulation of Dual problem; Primal-Dual relationships; Fundamental Theorem of Duality; Complimentary Slackness.

Assignment Problem: Mathematical formulation and Hungarian method of solving. Transportation Problem: Definition and formulation; Methods of finding initial basic feasible solutions; North West corner rule. Least cost method; Vogel's Approximation method; Algorithm for solving Transportation Problem.

15. Attraction, Potential and Hydrostatics:

Attraction and Potential of rods, rectangles and circular discs, spherical shell, sphere, Laplace's and Poisson's equations, theorems on equipotential surfaces.

Perfect fluid. Pressure at a point. Pressure of heavy fluid. Pressure at any point of a fluid at rest is the same in every direction. Conditions of equilibrium for homogeneous, heterogeneous, and elastic fluid.

Lines of force. Surfaces of equal pressure and density. Pressure gradient, pressure function and equation of equilibrium. Homogeneous fluid at rest under gravity.

Definition of centre of pressure. Formula for the depth of the centre of pressure of a plane area. Position of centre of pressure.

Thrusts on plane and curved surfaces. Rotating fluid. Pressure at any point and surfaces of equi-pressure when a mass of homogeneous fluid contained in a vessel revolves uniformly about a vertical axis. Floating bodies. Stability of equilibrium of floating bodies.

16. Probability & Statistics:

Sample space, Probability set function, Real random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions, Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function.

Discrete distributions: Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions: Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution.

Joint cumulative distribution function and its properties, Joint probability density function, Marginal distributions, Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations.

The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables, Linear regression for two variables, The method of least squares, Bivariate normal distribution, Chebyshev's theorem, Strong law of large numbers, Central limit theorem and weak law of large numbers.

Syllabus for Art of Teaching and Other Skills STET 2023

Unit II Art of Teaching, Other skills **Marks 50**
(A) Art of Teaching **Marks 30**
(B) Other skills **Marks 20**

A. Art of Teaching

1. Teaching & Learning:- Meaning, Process & Characteristics.
2. Teaching Objectives and Instructional objectives: Meaning & Types, Blooms Taxonomy.
3. Teaching Methods: - Types and its Characteristics, Merit, and demerits of Methods.
4. Lesson Plan: - Types and Format & Various Model.
5. Microteaching & Instructional analysis.
6. Effective ecosystem of Classroom.
7. Textbook and library
8. Qualities of Teacher.
9. Evaluation & Assessment for learning.
10. Curriculum.
11. Factors affecting teaching and learning.

12. Teaching Aids and Hands on learning.

B. Other skills

1. General Knowledge,

2.Environmental Science

3. Mathematical aptitude,

4.logical Reasoning