Maharashtra Public Service Commission

Civil Services Exam – Mains Optional

Mathematics

(Code No : 604)

Paper - I

Standard : Degree. **Total Marks** : 200
Nature of Paper : Conventional Type **Duration** : 3 Hours

Note : 1) Answers to this paper must be written in English only.
2) This paper will test the candidate's ability to comprehend, to analyse, to interpret, to criticise and to appraise the subject matter related to the topics/sub topics mentioned below.
3) It is expected from candidates to study the latest and recent developments and happenings pertaining to the topics/sub topics mentioned below.

Section - A (Marks : 50)

1) Linear Algebra :

.01) Vector spaces, linear dependence and independence, subspaces, bases, dimensions, finite dimensional vector spaces.

.02) **(i)** Matrices, Cayley-Hamilton theorem, eigen values and eigen vectors, matrix of linear transformation.

(ii) Row and column reduction, echelon form, equivalence, congruence and similarity, reduction to cannonical form.

(iii) rank, orthogonal, symmetrical, skew symmetrical, unitary, Hermitian, skew-Hermitian forms and their eigenvalues.

.03) Orthogonal and unitary reduction of quadratic and hermitian forms, positive definite quadratic forms.

Section – B (Marks : 50)

2) Calculus :

.01) Functions of a real variable, limits, continuity, differentiability, mean-value theorems, Taylor's theorem with remainders, indeterminate forms, maxima and minima, asymptotes.

.02) Functions of several variables, continuity, differentiability, partial derivatives, maxima and minima, Lagrange's method of multipliers, Jacobian.

.03) Riemann's definition of definite integrals, indefinite integrals, infinite and improper integrals, beta and gamma functions.

.04) Double and triple integrals (evaluation techniques only), area and volume, centre of gravity.

Section - C (Marks : 50)

3) Analytic Geometry and Vector Analysis :

.01) **(i)** Cartesian and polar coordinates in two and three dimensions, second degree equations in two and three dimensions.

(ii) Reduction to cannonical forms, straight lines, shortest distance between two

skew lines, plane, sphere, cone, cylinder, paraboloid, ellipsoid, hyperboloid of one and two sheets and their properties.

.02) **(i)** Scalar and vector fields, triple products, differentiation of vector function of a scalar variable, Gradient, divergence and curl in cartesian, cylindrical and spherical coordinates and their physical interpretations.

(ii) Higher order derivatives, vector identities and vector equations.

Section - D (Marks : 50)

4) Statics and Dynamics :

.01) Degree of freedom and constraints, rectilinear motion, simple harmonic motion, motion in a plane, projectiles, constrained motion, work and energy, conservation of energy, motion under impulsive forces, Kepler's laws, orbits under central forces, motion of varying mass, motion under resistance.

.02) Equilibrium of a system of particles, work and potential energy, friction, common catenary, principle of virtual work, stability of equilibrium, equilibrium of forces in three dimensions.

.03) **(i)** Generalised coordinates, constraints, holonomic and non-holonomic systems, D' Alembert's principle and Lagrange's equations.

(ii) Hamilton's equations, moment of intertia, motion of rigid bodies in two dimensions.

Paper - II

Standard : Degree. **Total Marks** : 200

Nature of Paper : Conventional Type **Duration** : 3 Hours

Note: 1) Answers to this paper must be written in English only.

2) This paper will test the candidate's ability to comprehend, to analyse, to interpret, to criticise and to appraise the subject matter related to the topics/sub topics mentioned below.

3) It is expected from candidates to study the latest and recent developments and happenings pertaining to the topics/sub topics mentioned below.

Section – A (Marks : 50)

1) Algebra :

.01) **(i)** Groups, subgroups, normal subgroups, homomorphism of groups, quotient groups, basic isomorphism theorems.

(ii) Sylow's Theorems, permutation groups, Cayley's Theorem.

.02) **(i)** Rings and ideals, principal ideal domains, unique factorization domains and Euclidean domains.

(ii) Field extensions, finite fields.

Section – B (Marks : 50)

2) Analysis :

.01) Real number system ordered sets, bounds, ordered field, real number system as an ordered field with least upper bound property, open and closed sets, Bolzano-Weirstrass and Heine-Borel theorems, Cauchy sequences, completeness.
Continuity and uniform continuity of functions, properties of continuous functions on compact sets.

.02) Absolute and conditional convergence of series of real numbers, rearrangement of series. Uniform convergence, continuity, differentiability and integralibility for

sequences and series of functions.

.03) **(i)** Analytic functions, Cauchy- Riemann equations, Cauchy's theorem, Cauchy's integral formula, Power series, Taylor's series.

(ii) Laurent's series, Singularities and Cauchy's residue theorem for evaluation of contour integrals.

Section – C (Marks : 50)

3) Differential equations :

.01) Formulation of differential equations, first order differential equations and various methods of solving them, singular solutions, linear differential equations with constant coefficients.

.02) Differentiation of functions of several variables, directional and partial derivatives, change in the order of partial derivatives, Mean value theorem, Inverse and implicit function theorems.

.03) **(i)** Curves and surfaces in three dimensions, formulation of partial differential equations, solutions of equations of type dx/p=dy/q=dz/r; orthogonal trajectories, pfaffian differential equations, partial differential equations of the first order, solution by Cauchy's method of characteristics, Charpit's method of solutions.

(ii) Linear partial differential equations of second order with constant coefficients, equations of vibrating string, heat equation, Laplace equation.

Section - D (Marks : 50)

4) Numerical Analysis and Graph Theory :

.01) **(i)** Numerical methods for solution of algebraic and transcendental equations of one variable by bisection, Regula-Falsi and Newton-Raphson methods.

(ii) Solution of system of linear equations by Gaussian elimination and Gauss-Jordan (direct) methods, Gauss-Seidel (iterative) method. Newton's (Forward and Backward) and Lagrange's method of interpolation.

.02) Numerical integration methods such as Simpson's one-third rule, trapezoidal rule, Gaussian quardrature formula.

.03) Linear programming problems, basic solution, basic feasible solution and optimal solution, graphical method and Simplex method of solutions, Duality.

.04) Graphs, Isomorphism, Connectivity, Trees, Spanning trees, Shortest path algorithm, Eulerian graphs and Hamiltonian graphs.

*****