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RPSC स्कूल व्याख्याता (School Lecturer, 1st Grade)

Syllabus — पेपर II — गणित

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RAJASTHAN PUBLIC SERVICE COMMISSION, AJMER

SYLLABUS OF COMPETITIVE EXAMINATION FOR THE POST OF LECTURER (SCHOOL EDUCATION)
MATHEMATICS

PAPER – II

Part– I Senior Secondary Level

1. **Sets, Relations and Functions**:
   Sets and their representations. Different kinds of sets. Sub set, Universal set, Venn diagrams. Operation on Sets. De-Morgan's laws and practical problems based on them. Ordered pair, Cartesian product of sets, relation, domain, co-domain and range of relation, equivalence relation. Function as a special case of relation, domain, co-domain, range of functions, invertible functions, even and odd functions, into, onto and one-to-one functions, special functions (polynomial, trigonometric, exponential, logarithmic, absolute value, greatest integer etc.), sum, difference, product and composition of functions.
2. **Trigonometry**:
   Measuring angles in radians and in degrees, trigonometric functions and their graphs, trigonometric identities. General solution of trigonometric equations. Inverse trigonometric functions (principal value only) and their elementary properties.
3. **Algebra:**
   Quadratic equation with real coefficients, formation of quadratic equation with given roots, relation between roots and coefficients. Symmetric functions of roots. Linear and quadratic inequations. Algebra of complex numbers, addition, multiplication, conjugation, polar representation, properties of modulus and principal argument, triangle inequalities, cube roots of unity, geometric interpretations of complex number. Arithmetic and geometric progressions, n^{th} term, sum of n terms, arithmetic and geometric means, infinite geometric series, Arithmetico-Geometric Progression. Sum of the first 'n' natural numbers, sums of squares and cubes of the first 'n' natural numbers, Fundamental principle of counting. Factorial n (n!). Permutations and Combinations and simple applications. Exponential and logarithmic series, Binomial theorem, simple applications, general term and middle term, properties of binomial coefficients.
4. **Matrices and Determinants**:
   Matrices, algebra of matrices, type of matrices, transpose of a matrix, symmetric and skew symmetric matrices. Operations on matrices: Addition, multiplication and multiplication with a scalar. Determinants of order two and three, properties of determinants, minors, co-factors and applications of determinants in finding the area of a triangle, Adjoint and inverse of a square matrix, inverse of matrix using elementary transformations, Test of consistency and solution of simultaneous linear equations in two and three variables using determinants and matrices.

5. **Two-Dimensional Geometry**:

Cartesian coordinates, distance between two points, section formulae, shift of origin. Equation of a straight line in various forms, slop of line, angle between two lines, distance of a point from a line, lines through the point of intersection of two given lines, equation of the bisector of the angle between two lines, concurrency of lines. Centroid, orthocenter, incentre and circumcenter of a triangle. Equation of a circle in various forms, equation of tangent, normal and chord of a circle. Parametric equations of a circle, intersection of a circle with a straight line/ circle, equation of a circle through the points of intersection of two circles and those of a circle and a straight line. Equation of a parabola, ellipse, hyperbola and their foci, directrices and eccentricity, parametric equations, equations of tangent and normal. Problems based on locus.

General equation of second degree. Nature of conic. Polar equation of a conic, polar equation of tangent, normal, asymptotes, chord of contact, auxiliary circle, director circle of a conic and related problems.

6. **Calculus**:

Limits, continuity and differentiability. Differentiation of the sum, difference, product and quotient of two functions. Chain rule, derivative of composite functions, derivatives of trigonometrical, inverse trigonometric functions, derivative of implicit functions. Derivatives of logarithmic and exponential functions. Logarithmic differentiation, derivative of functions expressed in parametric forms. Second and third order derivatives. Rolle’s and Lagrange's Mean value Theorems, Applications of derivatives: Rate of change of quantities, monotonic increasing and decreasing functions, Maxima and minima of functions of one variable, tangent and normal. Integral as an anti-derivative, Integration of a variety of functions by substitution, by partial fractions and integration by parts. Integration of rational and irrational functions. Definite integral and their properties, application of definite integrals in finding the area under simple curves, especially lines, arcs of circles/parabolas/ellipses/hyperbola, area between the said curves (the region should be clearly identifiable).

7. **Vector Algebra**:

Vectors and scalars, magnitude and direction of a vector. Direction cosines/ratios of vectors. Types of vectors (equal, unit, zero, parallel and collinear vectors etc.), position vector of a point, negative of a vector, components of a vector, addition of vectors, multiplication of a vector by a scalar, position vector of a point dividing a line segment in a given ratio. Scalar (dot) product of vectors, projection of a vector on a line. Vector (cross) product of vectors. Scalar and Vector triple product and problems related to them.

8. **Statistics and Probability**:

Measures of dispersion: Standard deviation, variance and mean deviation for grouped and ungrouped data. Probability: Probability of an event, addition and multiplication theorems of probability, conditional probability, Bayes’ theorem, total probability, probability distribution of a random variate, Bernoulli trials and binomial distribution.

Part– II Graduation Level

1. **Abstract Algebra**:
   Definition and example of groups. General properties of groups, Order of an element of a group. Cyclic group, Permutations: Even and Odd permutations. Groups of permutations. Cyclic permutation, Alternating group. Subgroups, Cosets, Lagrange's theorem, Normal subgroup, Conjugate elements, conjugate complexes, Centre of a group, Simple group, Normaliser of an element and of a complex. Quotient Groups. Group homomorphism and isomorphism with elementary basic properties, fundamental theorem of homomorphism in groups. Isomorphism theorems of groups. Cayley's theorem. Ring Theory: Introduction to Rings, Zero divisors, Division ring, Integral Domain and Fields, their examples and properties. Ideals of a ring, Quotient rings.
2. **Complex Analysis**:
   Functions, Limits, Continuity and Differentiability of complex functions. The extended plane and its spherical representation, Concept of an analytic function, Cartesian and Polar form of Cauchy-Riemann equations. Harmonic functions, Construction of an analytic function, Conformal mapping, Bilinear transformation and its properties, Fixed points, Cross ratio, Inverse point.
3. **Advance Calculus**:
   Polar Co-ordinates. Angle between radius vector and the tangent. Angle between two curves in polar form. Length of polar tangent, sub-tangent, normal and subnormal, Pedal equation of a curve, Derivatives of an arc. Curvature, various formulae, Centre of curvature and chord of curvature and related problems. Partial differentiation, Euler's theorem on homogeneous functions, Chain rule of partial differentiation, total differentiation. Maxima and Minima of functions of two independent variables and of three variables connected by a relation, Lagrange's Method of undetermined multipliers. Asymptotes, double points, curve tracing. Envelopes and evolutes. Theory of Beta and Gamma functions. Differentiation and integration under the sign of integration. Double integral, Change of order of integration and changing into polar co-ordinates, applications in finding areas, triple integral, application to find volume. Dirichlet's integral. Quadrature and Rectification. Volume and Surface area of solids of revolution.
4. **Ordinary and Partial Differential Equations**:
   Order and degree of differential equation. Ordinary differential equations of first order and first degree, differential equations of first order but not of first degree, Clairaut's equations, general and singular solutions, linear differential equations with constant coefficients, homogeneous differential equation, second order linear differential equations, simultaneous linear differential equations of first order. Partial differential equations of the first order. Linear partial differential equation with constant coefficient.

5. **Vector Calculus**:
   Vector differentiation: Curl, Gradient and Divergence, identities involving these operators and related problems. Vector integration: line and surface integral, Problems based on Stoke, Green and Gauss theorems.
6. **Three-Dimensional Geometry:**
   Distance between two points, direction cosines and direction ratios, equation of a straight line in space, various form, skew lines, shortest distance between two lines, equation of a plane, various form, distance of a point from a plane and a line, Cartesian and vector equation of a plane and a line. Angle between (i) two lines, (ii) two planes (iii) a line and a plane. Coplanar lines.
   Sphere: Equation of a sphere in various forms, tangent plane, Pole and Polar, Intersection of two spheres, Orthogonal spheres. Cone, Enveloping cone, Tangent plane, Reciprocal cone, three mutually Perpendicular generators, right circular cone. Cylinder, right circular cylinder, Enveloping cylinder.
7. **Statics and Dynamics**:
   Composition and resolution of co-planer forces, component of a force in two given directions, equilibrium of concurrent forces, parallel forces and moment, Equilibrium of a body under several coplaner forces. Friction, Virtual work and common catenary.
   Velocity and acceleration, Velocities and accelerations along radial and transverse directions, and along tangential and normal directions, simple linear motion under constant acceleration, Laws of motion, projectile, Simple Harmonic Motion, Rectilinear motion under variable laws. Hook's law, linear motion in resisting medium, constrained motion on smooth plane curves (circular and cycloidal motion).

Part– III Post Graduation Level

1. **Real Analysis:**
   Real numbers as a complete ordered field, linear sets, lower and upper bounds, limit points, closed and open sets. Real sequence, limit and convergence of a sequence, convergence of series, tests for convergence of a series, absolute convergence, uniform convergence of sequence and series of functions.
2. **Linear Algebra and Metric Spaces**:
   Definition and examples of a vector space, subspace of a vector space. Linear combination, Linear dependence and independence of vectors. Direct product of vector spaces and internal direct sums of subspaces. Bases and dimension of a finitely generated spaces, Quotient space, Isomorphism, Linear transformation (Homomorphism), Rank and nullity of linear transformation. The characteristic equation of a matrix, Eigen values and Eigen vectors, Cayley-Hamilton theorem. Definition and example of a metric space, Diameter of a set, Bounded set, Open sphere, Interior point and Interior of a set, Derived and Closure of set, Closed set, Closed Sphere, Properties of Open and Closed sets, Boundary point of set, Convergent and Cauchy sequences, complete metric space, Cantor's Intersection theorem. Bolzano-

Weierstrass theorem, Heine-Borel theorem, Compactness, connectedness, Cantor's ternary set.

3. **Integral Transforms and Special Function**:
   Laplace transform: Definition and its properties. Rules of manipulations, Laplace theorems of derivatives and integrals, Properties of Inverse Laplace transforms, Convolution theorem, Complex inversion formulas, applications to the solutions of ordinary differential equations with constant and variable coefficients. Fourier Transform: Definition and properties of Fourier sine, cosine and complex transforms. Convolution theorem. Legendre's polynomial/ Functions: Legendre's differential equation and associated Legendre's differential equations, Simple properties of Legendre's functions of first and second kind. Bessel functions, Generating function, Integral formulae, Recurrence relations, Addition formula and other properties of Bessel functions.
4. **Differential Geometry and Tensors:**
   Differential Geometry: Curves in Space- Space curves, Contact of a curve and a surface. Definition of unit tangent vector, tangent line, Principal Normal, Binormal and Normal plane.
   Tensors: Transformation of coordinates, Contravariant, covariant and mixed tensors, second order tensors, Higher order tensors. Addition, subtraction and multiplication of tensors, Contraction, Quotient Law, symmetric and skew symmetric tensors: Conjugate symmetric tensors of the second order, Fundamental tensor, Associated tensors, Christoffel symbols, Transformation law of Christoffel symbols, Covariant differentiation of vectors and tensors.
5. **Numerical Analysis**:
   Difference operators and factorial notation, Differences of polynomial, Newton’s formulae for forward and backward interpolations. Divided differences, relation between divided differences and Simple difference. Newton’s general interpolation formulae, Lagrange interpolation formula. Central differences, Gauss, Stirling and Bessel interpolation formulae. Numerical Differentiation. Numerical integration, Newton-Cotes quadrature formula, Gauss’s, quadrature formulae, Trapezoidal, Simpson’s and Weddle’s rules. Estimation of errors, Transcendental and polynomial equations, bisection method, iteration method, Regula Falsi method, Newton Raphson method.
6. **Optimization Technique**:
   Convex sets and their properties. Simplex Method. Concepts of duality in linear programming. Framing of dual programming. Assignment problems, Transportation problems. Theory of Games: Competitive strategies, minimax and maximin criteria, two-person zero-sum games with and without saddle point.

Part – IV (Pedagogy, Teaching Learning Material, Use of Computers and Information Technology in Teaching Learning)

I. Pedagogy and Teaching Learning Material (Instructional Strategies for Adolescent Learner)

- Communication skills and use of various verbal and non verbal classroom communication strategies.
- Teaching models- advance organizer and inquiry training (information processing) Group Investigation (Social Interaction) Non-Directive model (Personal development).
- Preparation and use of teaching-learning material during teaching.
- Cooperative learning.

II. Use of Computers and Information Technology in Teaching Learning

- Concept of ICT and Digital learning
- E-learning and Virtual Classroom.
- Technology integration in teaching-learning and assessment.

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For the competitive examination for the post of **School Lecturer: -**

The question paper will carry maximum **300 marks**.

1. Duration of question paper will be **Three Hours**.
2. The question paper will carry **150 questions** of multiple choices.
3. Negative marking shall be applicable in the evaluation of answers. For every wrong answer one third of the marks prescribed for that particular question shall be deducted.
4. Paper shall include following subjects: -
   (i) Knowledge of Subject Concerned: Senior Secondary Level
   (ii) Knowledge of Subject Concerned: Graduation Level.
   (iii) Knowledge of Subject Concerned: Post Graduation Level.
   (iv) Pedagogy, Teaching Learning Material, Use of Computers and Information Technology in Teaching Learning.