RAJASTHAN PUBLIC SERVICE COMMISSION, AJMER

SYLLABUS FOR SCREENING TEST FOR THE POST OF JUNIOR GEOPHYSICIST- GEOPHYSICS GROUND WATER DEPARTMENT

1. Solid Earth Geophysics:

Introduction to Geophysics, Different branches of Geophysics and relationship with other sciences. Formation of solar system, its origin, characteristics of planetary members, Earth; its rotation and figure of earth. Age of earth various methods of determination. Tectonics and Geodynamics, Thermal history and its characteristics. Gravity field of earth and Isostasy. Geomagnetism, elements of earth's magnetism: Internal, External fields and their causes, Paleomagnetism, Polar wandering paths, Seafloor spreading, geophysical evidences. Elastic waves, internal structure of earth, variation of physical properties in the interior of earth.

2. Earthquake and Engineering Seismology:

Introduction to Seismology, Phenomena of earthquakes, Concept of focus, focal depth, epicenter, great Indian earthquakes, Intensity and Magnitude scales, Energy of earthquakes, foreshocks, aftershocks, Elastic Rebound Theory, Fault plane solutions, Seismicity and Seismotectonics of India, Frequency-Magnitude relation (b values), Velocity structure, Vp/Vs studies. Different types of elastic waves, their propagation characteristics. Seismic ray theory for spherically and horizontally stratified earth, basic principles of Seismic Tomography and receiver function analysis, Seismic network and arrays, telemetry systems, Earthquake prediction; dilatancy theory, short-term, middle-term and long- term predictions, Seismic microzonation studies, application for engineering problems, Seismometry, Principle of electromagnetic seismograph, displacement meters, velocity meter, accelerometer, WWSSN stations, seismic arrays for detection of nuclear explosions.

3. Remote Sensing and GIS Applications:

Fundamental concepts of remote sensing, electromagnetic radiation spectrum, energy frequency-wavelength relationship, Boltzman Law, Wien Law, electromagnetic energy and its interactions in the atmosphere and with terrain features; elements of photographic systems, reflectance and emittance, false color composites, remote sensing platforms, flight planning, geosynchronous and sun synchronous orbits, sensors, resolution, parallax and vertical exaggeration, relief displacement, mosaic, aerial photo interpretation and geological application. Fundamentals of photogrammetry, satellite remote sensing, multispectral scanners, thermal scanners, microwave remote sensing, fundamental of image processing and interpretation for geological applications. Introduction to Geographic Information Systems (GIS) spatial data structures, visualization and querying, spatial data analysis.

4. Borehole Geophysics (Principles of Well logging):

Objectives of well logging, fundamental concepts in borehole geophysics, borehole conditions, properties of reservoir rock formations, formation parameters and their relationships- formation factor, porosity, permeability, formation water resistivity, water saturation, irreducible water saturation, hydrocarbon saturation, residual hydrocarbon saturation; Arhcie's and Humble's equations; principles, instrumentations, operational procedures and interpretations of various geophysical logs, SP log, resistivity and micro resistivity logs, nuclear/radioactive logs, acoustic impedance and propagation logs, temperature log, caliper log and directional logs; production

logging; clean sand and shaly sand interpretations; overlay and cross-plots of well-log data, determination of formation lithology, sub-surface correlation and mapping, delineation of fractures; application of well-logging in groundwater.

5. Geophysical Potential Fields (Gravity and Magnetic):

Geophysical potential fields, Inverse Square Law of field, Principles of Gravity and Magnetic methods, Geoid, Spheroid, Nature of gravity and its variation, Properties of Newtonian potential, Laplace's and Poisons equations, Green's theorem, Gauss law, Concept of Bouguer gravity anomaly, Rock densities, factors controlling rock densities, determination of density, Theory of Isostacy, Earth's main magnetic field, origin, temporal variations, Geomagnetic elements, Coulmb's Law of magnetic force and fields, intensity of magnetization and induction, magnetic potential and its relation to field, units of measurement, origin of magnetic anomalies, interrelationship between different components of anomalies, Poison's relation, Magnetic susceptibility, factors controlling susceptibility (Bulk chemistry, cooling history, metamorphism), magnetic minerals, rock classification, Natural and remnant magnetism, demagnetization effects. Plan of conducting GM surveys, reduction of gravity and magnetic data, magnetic gradient surveys, Shipborne surveys, Gravity and Magnetic data reduction, IGSN Gravity bases, International Gravity formula, IGRF corrections for magnetic field. Separation of regional and residual anomalies, ambiguity in interpretation, Data processing and interpretation of anomalies, modeling of anomalies.

6. Electrical Methods :

Electrical properties of rocks and their measurement, concepts and assumptions of horizontally stratified earth, anisotropy and its effects on electrical fields, the geo electric section and geological section, D.C Resistivity method, fundamental Laws, concept on natural electric field, electrode configuration, choice of methods, Profiling, Vertical Electrical Sounding. SP Method, Origin of SP, application of SP surveys, Origin of Induced Polarization, Membrane and Electrode potential, time and frequency domains of measurement, IP, chargeability, percent frequency effect and metal factor, Dipole Theory of IP.

7. **Electromagnetic Methods:**

Electromagnetic methods/ Telluric/Magneto Telluric methods, Passive and Active source methods, Maxwell's equations, electromagnetic potential and wave equations, boundary conditions, long wave length approximation, depth of penetration, amplitude and phase relations, real and imaginary components, Principles of EM prospecting, various EM methods, Dip angle method, Turam method, moving source-receiver methods-horizontal loop (Slingram) method, AFMAG and VLF methods, Airborne EM systems – rotary field method, INPUT method, EM Profiling and sounding, Interpretation of EM anomalies, Origin and characteristics of MT fields, Field methods and interpretation of MT data and applications.

8. Seismic Prospecting:

Basic principles of seismic methods, Fermat's principle, Snell's Law, Reflection, refraction and diffraction from multilayered medium, Reflection and transmission coefficients, propagation model for exploration seismology, Seismic resolution, Seismic absorption and anisotropy, Seismic data acquisition, sources of energy, Geophones, geometry of arrays, digital recording, Seismic Surveys: Principle for multilayer refraction, Travel time curves, corrections, Interpretation of data, Reflection principles, CDP, data processing, corrections, NMO correction, Interpretation of data, Fundamental of VSP method, Seismic Tomography.

9. **Radiometric Exploration / Airborne Geophysical Surveys for Geological Mapping:**
Principles of radioactivity, radioactivity decay processes, units, radioactivity of rocks and minerals, Radiometric prospecting for mineral exploration (Direct/Indirect applications), Radiometric prospecting. Airborne geophysical surveys, planning of surveys, sensors, data corrections, flight path recovery methods, applications in geological mapping, interpretation of maps, identification of structural features, altered zones.

10. **Digital Signal Processing:**
Various types of signals, sampling theorem, aliasing effect, Fourier series and periodic waveforms, Fourier transform and its properties, Discrete Fourier transform and FFT, Auto and cross correlations, Power spectrum, Delta function, unit step function. Time domain windows, Z transform and properties, Inverse Z transform, Principles of digital filters, types of filters, moving average and recursive and non recursive filters Amplitude and phase response filters low pass, band pass and high pass filters, Processing of Random signals.

11. **Mathematical Methods in Geophysics:**
Properties of scalars, vectors and tensors, Elements of vector analysis, Gradient, Divergence and Curl, Gauss's Divergence Theorem, Stokes theorem, Definition of fields, Gravitational field, Newton's Law of gravitation, Gravitation potential and fields due to bodies of different geometric shapes, Electrostatic field, Coulomb's Law, Electrical permittivity and dielectric constant, Basic guiding equations, Magnetostatic field, Origin of Magnetic field, Ampere's Law, Biot and Savart's Law, Geomagnetic fields, Magnetic fields due to different type of structures, Solution of Laplace equation in Cartesian Coordinate, Cylindrical Polar Coordinate and Spherical Polar Cordinate, Complex Variables in Potential theory, Green's theorem in Potential Theory. Concept of Image in Potential Theory, Analytical continuation in Potential fields, Numerical Methods in Potential Theory. Electrical fields in geophysics, point source, continuous distribution and double layers, equipotential and line of force. Current and potential in the earth, basic concept and equations of electromagnetic, Maxwell's equations, boundary conditions, elliptic polarization, electromagnetic potential and waves, radiation from dipoles, retarded potential, near and far fields, radiation resistance, EM field of a loops of wire on half space, multi-layered media, impedance and its application.

12. **Geophysical Inversion:**
Fundamental concepts of inverse theory, Basic definition of inversions with application to Geophysics. Probability, Inverses with discrete and continuous models. Forward problems versus Inverse problems. Formulation of inverse problems and their relation to a matrix problem, linear inverse problems, classification of inverse problems, least square solutions and minimum norm solution, concept of norms, concept of 'a priori' information, constrained linear least square inversion, review of Matrix Theory, Introduction to finite difference method, forward, backward and central difference method. Application of finite difference method for solving Helmholtz equation. Introduction to finite element method, various steps, simple examples showing application of finite element method. Models and data spaces, householder transformation, data resolution matrix, model resolution matrix, Eigen values and Eigen vectors, Singular Value Decomposition (SVD), generalized inverses, Non-linear inverse problems, Gauss Newton method, Steepest Descent (gradient) method, Marquardt-Levenberg method, Earthquake location problem, tomography problem, Probabilistic approach of inverse problems, Maximum Likelihood and Stochastic Inverse methods, Backus-Gilbert method, Global optimization techniques, genetic algorithm, Simulated Annealing methods, examples of inverting geophysical data.

13. Geophysical Equipments:

Gravitymeters: Principles of gravitymeters, stable and unstable gravitymeters, Zero length spring, Calibration of gravitymeter, Magnetometers: Principles and operations of fluxgate, proton precession and optical pumping magnetometers. D.C. and A.C. resistivity meters. Time domain and frequency domain IP and EM equipments, Seismographs: Principle of electromagnetic seismograph, Short period, long period and Broad band sensors, Accelerometer Engineering seismograph. Principle and operation of GPR and antennae. Principle of geophone and hydrophone, G-M counter, Scintillation meter, Gamma ray spectrometer.

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Pattern of Question Papers:

1. Objective Type Paper
2. Maximum Marks : 150
3. Number of Questions : 150
4. Duration of Paper : 2:30 Hours
5. All Questions carry equal marks
6. Medium of Screening Test: Bilingual in English & Hindi
6. There will be **Negative Marking**

(For every wrong answer, one-third of marks prescribed for that particular question will be deducted).

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