RAJASTHAN PUBLIC SERVICE COMMISSION, AJMER
Syllabus for Screening Test for the post of Junior Geophysicist,
Mines & Geology Department.

Solid Earth Geophysics:

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, Strong motion seismograph, seismic arrays for detection of nuclear explosions, Broadband seismometry.

Remote Sensing and GIS applications:
Fundamental concepts of remote sensing, electromagnetic radiation spectrum, energy-frequency-wavelength relationship, Boltzmann 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.

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 hydrocarbon, groundwater, coal, metallic and non-metallic mineral exploration.

**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 Poissons 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, Coulomb’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, Poisson’s relation, Magnetic susceptibility, factors controlling susceptibility (Bulk chemistry, cooling history, metamorphism..), magnetic minerals, rock classification, Natural and remnant magnetism, Asiatic and Spinner magnetometers, demagnetization effects.


**Electrical and Electromagnetic 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, Application of IP surveys for mineral exploration (disseminated sulphides)

**Seismic Prospecting:**
Basic principles of seismic methods, Fermat’s principle, Senell’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, Instrumentation, 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. Principles of High Resolution Seismic (HRS) for coal exploration

**Radiometric Exploration / Airborne Geophysical surveys for Geological Mapping:**
Principles of radioactivity, radioactivity decay processes, units, radioactivity of rocks and minerals, Instruments, Ionisation chamber, G-M counter, Scintillation meter, Gamma ray spectrometer, Radiometric prospecting for mineral exploration (Direct/Indirect applications), Radiometric prospecting for beach placers, titanium, zirconium and rare-earths, portable gamma ray spectrometry and radon studies in seismology, environmental applications, logging methods, radiometric dating techniques
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.

**Geophysical 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
Signal enhancement for gravity and magnetic maps; regional residual separation, continuations, evaluation of derivatives, pseudo gravity transformations, reduction to poles and equator, Improvement of signal to noise ratio, source and geophone arrays as spatial filters. Earth as low pass filter.

**Mathematical methods in Geophysics:**
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.

**Geophysical Inversion:**
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

**Note :- Pattern of question Paper**
1. Objective type paper.
2. Maximum Marks : 100
3. Number of Questions : 100
4. Duration of Paper : Two Hours
5. There will be Negative Marking
6. All Questions carry equal marks.

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