GATE 2014 Exam Syllabus for Geology and Geophysics (GG)

General Aptitude (GA)-Multiple Choice Test

- **This Paper Consists of Verbal Ability:** English grammar, verbal analogies, instructions, critical reasoning and verbal deduction, Sentence completion, Word groups

PART – A : COMMON TO GEOLOGY AND GEOPHYSICS

- Earth and Planetary system, shape,size, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; physical properties of the interior of the earth; continental processes and continents; geomagnetism, physical oceanography and paleomagnetism, plate tectonics, continental drift.
- Weathering; soil formation; action of river, glacier,wind and ocean; volcanism earthquakes, and orogeny. Basic structural geology, petrology and mineralogy .Geological time scale and geochronology; major stratigraphic divisions of India; stratigraphic principles . Engineering properties of rocks and soils. Ground water geology. Geological and geographical distribution of coal, ore and petroleum resources of India.
- Introduction to remote sensing.Physical basis and applications of gravity, electrical, magnetic, electromagnetic, seismic and radiometric prospecting for mineral, Oil and ground water; introductory well logging.

PART B – SECTION 1: GEOLOGY

- Crystal symmetry, twinning, forms ; crystal chemistry; classification of minerals, optical mineralogy, diagnostic physical and optical properties of rock forming minerals.
- Igneous rocks – classification, textures and forms , magmatic differentiation; phase diagrams and trace elements as monitors of magma evolutionary processes; mantle melting models and derivation and primary magmas. Metamorphism; metamorphic facies ,controlling factors, grade and basic types; metamorphism of pelitic, mafic and impure carbonate rocks; metamorphic P-T-t paths and their tectonic significance; role of fluids in metamorphism ;Igneous and metamorphic provinces of India; structure and petrology of sedimentary rocks; sedimentary facies, sedimentary processes and

environments, association of igneous, basin analysis ;sedimentary and metamorphic rocks with tectonic setting.

- strain, Stress and material response; ductile and brittle deformation; secondary and primary structures; genesis and geometry of folds, joints, faults, unconformities; schistosity, cleavage and lineation; methods of projection, tectonites and their significance; superposed folding; shear zone; basement cover relationship.
- Classification, Morphology, and geological significance of important vertebrates, invertebrates, microfossils and palaeo flora; stratigraphic principles and Indian stratigraphy.
- Geomorphic processes and agents; development and evolution of landforms; drainage and slope; processes on deep oceanic and near-shore regions; applied and quantitative geomorphology.
- Ore mineralogy and optical properties of ore minerals; ore forming processes vis-à-vis ore-rock association (hydrothermal, magmatic, sedimentary and metamorphogenic ores); ores and metamorphism; fluid inclusions as an ore genetic tool; prospecting and exploration of economic minerals; sampling, ore reserve estimation, geostatistics, mining methods. Petroleum and Coal geology; origin and distribution of mineral and fuel deposits in India; marine geology and ocean resources; ore dressing and mineral economics.
- Cosmic abundance; geochemical evolution of the earth; meteorites;geochemical cycles; distribution of minor, major and trace elements; elements of geochemical thermodynamics, geochemistry of waters including solution equilibria; isotope geochemistry and water rock interaction.
- rocks as construction materials ;Engineering properties of rocks and soils; role of geology in the construction of engineering structures including dams; natural hazards, tunnels and excavation sites. Ground water geology – exploration, well hydraulics and water quality. Basic principles of remote sensing – energy sources and radiation principles, atmospheric absorption, interaction of energy with earth's surface, air-photo interpretation, multispectral remote sensing in infrared, visible, thermal IR and microwave regions, digital processing of satellite images. GIS – basic concepts, vector and raster mode operation.

PART B – SECTION 2: <u>GEOPHYSICS</u>

- The earth as a planet; different motions of the earth; Clairaut's theorem, gravity field of the earth, size and shape of earth; seismology; geochronology and interior of the earth; variation of density, velocity, temperature, pressure, electrical and magnetic properties of the earth; earthquakes- measurements and causes , magnitude and intensity, earthquake quantification, focal mechanisms ;source characteristics, seismotectonics and seismic hazards; geomagnetic field, digital seismographs; paleomagnetism; continental and oceanic lithosphere; plate tectonics; heat flow; lower and upper atmospheric phenomena.
- Vector and Scalar potential fields; Laplace, Helmholtz and Maxwell equations for solution of different types of boundary value problems in cylindrical, Cartesian and

spherical polar coordinates; Green's theorem; integral equations in potential theory; Image theory; Eikonal equation and Ray theory. Basic concepts of inverse and forward problems of geophysics, Ill-posedness of inverse problems.

- 'g' and 'G' units of measurement, relative and absolute gravity measurements; airborne, land,shipborne and bore-hole gravity surveys; various corrections in gravity data reduction – free air, Bouguer and isostatic anomalies; regional and residual gravity separation; density estimates of rocks ;principle of equivalent stratum; downward and upward continuation; wavelength filtering; preparation and analysis of gravity maps; gravity anomalies and their interpretation – anomalies due to geometrical and irregular shaped bodies, calculation of mass, depth rules
- Earth's magnetic field –Elements, origin and units of measurement, magnetometers, magnetic susceptibility of rocks and measurements, airborne, Land and marine magnetic surveys, corrections, preparation of magnetic maps, downward and upward continuation, magnetic anomalies-geometrical shaped bodies, Image processing concepts in processing of magnetic anomaly maps; depth estimates; Interpretation of processed magnetic anomaly data.
- Conduction of electricity through rocks, electrical conductivities of metals, non-metals, rock forming minerals and different rocks, various electrode configurations for resistivity sounding and profiling, concepts of D.C. resistivity measurement , application of filter theory, Type-curves over multi-layered structures, Dar-Zarrouck parameters, coefficient of anisotropy, reduction of layers, interpretation of resistivity field data, equivalence and suppression, self potential and its origin, Induced polarization, time and frequency domain IP measurements; ground-water exploration, interpretation and applications of IP ,environmental and engineering applications.
- Basic concept of EM induction, elliptic polarization, Origin of electromagnetic field, methods of measurement for different source-receiver configuration, components in EM measurements. Skin-depth, interpretation and applications; tellurics, earth's natural electromagnetic field, magneto-tellurics; geomagnetic depth sounding principles, electromagnetic profiling, methods of measurement, processing of data and interpretation. Geological applications including groundwater, mining and hydrocarbon exploration.
- Seismic methods of prospecting; Reflection, refraction and CDP surveys; Elastic properties of earth materials; land and marine seismic sources, velocity – depth models, geophones, generation and propagation of elastic waves; hydrophones, recording instruments (DFS), field layouts, digital formats, seismic noises and noise profile analysis, noise cancellation by shot and geophone arrays, optimum geophone grouping, 2D and 3D seismic data acquisition, processing and interpretation; CDP stacking charts, filtering, binning ,dip-moveout, dynamic and static corrections, Digital seismic data processing, seismic deconvolution and migration methods, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, AVO, AVO. Reservoir geophysics.
- sampling theorem, Geophysical signal processing, aliasing, Nyquist frequency, Fourier series, periodic waveform, Z-transform and wavelet transform; power

spectrum, Fourier and Hilbert transform ,delta function, cross correlation, auto correlation,deconvolution, convolution, principles of digital filters, windows, Zeros and poles.

- Techniques and Principles of geophysical well-logging. SP, resistivity, induction, gamma ray, neutron, sonic, density, temperature, caliper, nuclear magnetic, dip meter, cement bond logging, micro-logs. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration.
- Radioactive methods of prospecting and assaying of minerals (non radioactive and radioactive) deposits, decay constant, half-life, radioactive equilibrium, G M counter, scintillation detector, semiconductor devices, application of radiometric for exploration and radioactive waste disposal.
- Geophysical inverse problems; non-uniqueness and stability of solutions; non-linear and quasi-linear methods including Tikhonov's regularization method, simulated annealing, genetic algorithms and artificial neural network, Backus-Gilbert method.