Department of Earth Sciences

Integrated Ph. D. Entrance Test Syllabi for Applied Geology
(Paper II and Paper III)

Note:
Part-II: Basic (conventional) questions on core papers (30 Marks);
Part-III: Advanced (higher value questions) questions on core papers (50 Marks)

Unit-1 Structural Geology and Global Tectonics

Mechanical properties of rocks and rock failure. Concept of stress and strain and their geological significance. Mechanics of folding and buckling. Faults and dynamics of faulting. Planer and linear fabrics in deformed rocks. Concept of petro-fabrics and symmetry. Interpretation of fabric data on microscopic and mesoscopic scale. Geometrical analysis of simple and complex structures on macroscopic scale.
Internal structure of the Earth. Plate tectonics and mountain building. Models of mountain building. Collision tectonics, Surge tectonics as an alternative geodynamic model. Isostasy and Paleomagnetism.

Unit-2 Paleobiology and Stratigraphy

Modern concepts of origin of life. Precambrian fossil record and origin of Metazoa. Taphonomy and fossil communities. Principles of biostratigraphy. Methods and techniques in palaeontology. Morphology and evolutionary trends in Ammonoids, Brachiopods, Graptolites and Trilobites. Morphology, classification, and evolutionary trends of Foraminifera, Ostracodes and Conodonts, their ecological and geological significance. Sequence of plant life through geological time. An account of Gondwana plant fossils of India with respect to paleoclimatic conditions. Morphology and applications of spores and pollens. Landmarks in the evolution of vertebrates. Extinction of Dinosaurs, Siwalik vertebrates. Phylogeny of Equidae and Proboscidae. Faunal changes with respect to tectonic and climate changes. Human evolution.
Principals of stratigraphy. Stratigraphic classification. International code of stratigraphic nomenclature. Concept of stratigraphic facies, stratigraphic correlation. Graphic representation of stratigraphic data. Seismic stratigraphy, magnetostratigraphy. Precambrian-Cambrian, Permian-Triassic, Cretaceous-Tertiary, and Pliocene-Pleistocene boundary problems in stratigraphy. Paleogeography, paleoclimate, igneous and mountain building activities in the Indian subcontinent from Late Cretaceous.

Unit-3 Sedimentology

Sedimentary processes. Sedimentary structures and textures. Use of textures and structures in sediment dispersal and basin studies. Classification of sediments; light and heavy minerals. Classification, environment of deposition, provenance and diagenesis of sandstones, carbonates and mudstones. Sedimentary environments and classification of environments, lithologies, structures and vertical sequences formed in alluvial, deltaic, coastal, and deep sea, and glacial and aeolian environments. Concept of sedimentary facies, Walters law of facies and application. Sedimentary cycles and cyclothems. Facies models and environmental reconstruction. Scalar

properties and paleocurrents. Paleogeographic reconstruction and basin analysis. Sedimentation and tectonics, basin evolution in relation to plate tectonics.

Unit-4 Mineralogy, Crystallography and Geochemistry

Pauling's rule, ionic substitution and crystalline solutions. Polymorphism and pseudomorphism. Exsolution and non-crystalline minerals (mineraloids). Concept and application of optical indicatrix and interference phenomenon. Orthoscopic and conoscopic study of minerals. Optic figure, optic sign, dispersion, pleochroism and absorption. Determinative methods of Refractive Index. Pleochroic scheme and 2V microscopic methods. Axiality and optic sign. Systematic mineralogy of silicates, sulphides, oxides, hydroxides and carbonates.

Geochemical classification of elements. Trace element geochemistry and concepts of partitioning and distribution coefficients of trace elements between solid and liquid phases vis-à-vis partial melting and magma generation. Distribution of REE in the Earth's mantle and crust. Isotope geochemistry, decay mechanism and growth of isotopes; Geochronological applications of Rb-Sr, K-Ar, U-Th-Pb and Sm-Nd systematics. Stable isotope geochemistry of oxygen and hydrogen.

Nature of crystals: distinction between crystalline and amorphous material. Parallel growth, crystal form, crystal habit. Twining-types, causes and laws.External & Internal symmetry in crystals; Symmetry elements; Improper axis; Combination of symmetry elements.

Crystal Systems: Normal classes of crystals, spherical and stereographic projections. Crystal structure of minerals: dimorphism, polymorphism, pseudomorphism, isomorphism, solid solution and Exsolution.

Unit-5 Igneous and Metamorphic Petrology

Magma; nature and cooling behaviour. Volatiles in silicate melts. Classification schemes of igneous rocks.

Phase equilibria: Unary, binary and ternary systems. Genesis and tectonic setting of different Magma types. Application of major and trace elements (including REE) and Sr-, Pb-, and Nd-isotopes studies in deciphering magma generation, mantle-crust interactions and tectonic environments.

Metamorphism and metamorphic processes. Metamorphic differentiation. Metamorphic facies and systematic description of regional and thermal metamorphism of pelitic, basic-ultra-basic and calcareous rocks. Metamorphic reactions and their implications to geothermo-barometry. Metasomatism and Anataxis. Regional metamorphism and paired metamorphic belts in reference to plate tectonics. P-T-t- paths.

Unit-6 Ore, Fuel & Exploration Geology

Principal mechanisms of formation of the igneous, sedimentary and metamorphic mineral deposits. Weathering and placer deposits. Ore deposits and plate tectonics. Mineral economics and national mineral policy in relation to strategic, critical and essential minerals. Ore Microscopy and quantitative methods in ore microscopy. Microchemical studies of ore minerals. Fluid inclusions and their importance in ore geology.

Origin and occurrence of petroleum. Migration and accumulation of petroleum. Reservoir rocks and traps. Petroliferous basins of India. Rank and grade of coal; origin of kerogen and coal.

Geological and geographical distribution of coal deposits in India with emphasis on Gondwana coal fields. Atomic minerals and mode of occurrence of atomic minerals in nature. Atomic minerals as source of energy and productive atomic mineral geological horizons in India.
Principles and methodology of geological prospecting for economic minerals and rocks, sampling methods, reserve estimation, grade and tonnage calculation of the deposits. Mining methods. Concept of geochemical dispersion and pathfinder elements, geochemical sampling and geochemical field techniques. Principle, procedure, equipment used and applicability of gravimetric, magnetic, electrical, seismic and radiometric geophysical methods. Aerial geophysical surveys.

Unit-7 Tectonic Geomorphology

Geomorphological cycle, Soils and classification of soils. Morphometric analysis of drainage basins. Relationship of morphometric parameters with discharge and sediment yield characters of basins. Morphometric evolution of western Himalayas. Tectonic Geomorphology; Energetics, Active Tectonics & Models of landscape development. Controversies in tectonic geomorphology. Geomorphic markers, landform dating techniques. Geomorphic expression of Faults. Palaeoseismology and field techniques in paleoseismology. Direct and indirect observations of paleoseismic displacements. Paleoseismic landforms; use of liquefaction-induced features and landslides for paleoseismic analysis. Quaternary cycles of climatic change and their effect on landforms. Geomorphic sub-divisions of Indian subcontinent and their geomorphic features and evolution with special reference to Himalayas.
Landslides, settlement and subsidence, slope modification and reinforcement, instruments for monitoring slope movements.

Unit-8 Hydrogeology

Groundwater table and Groundwater table fluctuations and controlling factors. Subsurface inflow and outflow; period of recharchage and discharge. Average groundwater fluctuations, effluent and influent streams. Elementary theory of groundwater flow: Darcy's law and its range of validity. Steady and unsteady flow. Porosity and permeability transmissivity, storage coefficient and methods of determination. Water table maps and flow net analysis; differential equation for controlling groundwater flow. Steady, unsteady and radial flow into a well. Confined and leaky confined and unconfined aquifers. Determination of aquifer characteristics from pump-tests. Groundwater exploration resistivity, magnetic and seismic geophysical methods. Borehole geophysical logging - electrical, resistivity and SP; Radiation logging gamma, gamma-gamma, and neutron logging. Cliper and temperature logging.
Preparation of strata charts. Design of tube well assembly and water well design criteria. Water level development and yield tests. Groundwater modelling techniques. Groundwater basin management methods: Basic ideas of groundwater management. Water logging and artificial recharge. Fresh and saltwater relationship in coastal areas. Groundwater quality analysis. Quality criteria for drinking, irrigation and industrial purposes. Pollution of groundwater. Groundwater and hydro-chemical provinces of India.

Unit-9 Remote Sensing and GIS

Concepts of Remote Sensing, electromagnetic radiations, matter interactions with atmosphere and terrain, reflectance, absorptance and transmittance. Spectral reflectance of vegetation, soils, minerals and rocks. Scattering processes, basic elements of visual image interpretation, principles of image interpretation. Verification and validation of RS data. Picture element and image statistics; pre-processing of satellite data, geometrical corrections of satellite data, image enhancements, types of enhancements, filtering of images. Digital image classification: supervised and unsupervised classifications. Sources of errors and measurement of map accuracy, kappa coefficient. Applications of remote sensing earth sciences, environmental sciences, surveying, hydrological modelling, ground water prospecting.

Geographic Information System (GIS) components of GIS, GIS software packages. Concept and types of information, integration of spatial and non-spatial data, raster and vector data models. Geospatial analysis for disaster management with case studies on landslides and floods. GIS for environmental applications like lake management and soil mapping.

Unit-10 Engineering & Environmental Geology

Engineering properties and classification of rocks. Factors affecting engineering services of rocks. Engineering properties of soils. Soil liquefaction and creep. Stress distribution in soil and foundation failure. Geological considerations for evaluation of dams, reservoir and tunnel sites, Foundation evaluation techniques. Influence of geological conditions on foundation and design of buildings.

Fundamental concepts of environmental geosciences. General relationship between landscape, climate and biomass. Geosciences factor in environmental planning. Earth processes and geological hazards with reference to floods, landslides, earthquakes, volcanism, and avalanches. Cenozoic climate extremes, their impact on evolution of life especially on human evolution. Energy resources and environment, Environmental effects associated with exploitation of hydrocarbons, coal and atomic minerals. Concept of health geochemistry. Natural chemical anomalies. Radon emission and health. Geological controls on radon emission levels. Radon emission survey. Use of geochemical maps in land use planning.

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