

PG ENTRANCE EXAM SYLLABUS – 2024

DOS IN EARTH SCIENCE

Introduction to earth system sciences

system science - fundamental concepts of the five spheres (lithosphere, hydrosphere, atmosphere, biosphere and cryosphere). Energy balance. Interactions between the five spheres; hydrologic cycle; Biogeochemical cycles - carbon cycle; Hydrosphere-atmosphere: Oceanic current system and effect of Coriolis force. Concepts of eustasy. Atmospheric circulation. Weather and climatic changes. Interrelationships between biological, geological, climatological, and human systems on continental and global scales. Anthropogenic influences on the Earth systems; Human- environment interactions - policy. The universe and solar system: Origin of the universe - Big bang theory. Solar system. Members of solar system – planets (Terrestrial and gaseous planets), satellite, comets, asteroids, meteorite.

Earth in the solar system. Size, shape, mass and density of the earth. Origin of the Earth – Gaseous hypothesis, Nebular hypothesis, Planetesimal hypothesis, Tidal hypothesis, Supernova hypothesis, Interstellar or dust or meteoric hypothesis. Evolution of earth. Age of the Earth: Geochronology; Absolute and relative methods; (a) Relative Methods - Sedimentation, Salinity method, varve chronology, Rate of cooling of earth. (a) Radiometric dating, atomic energy, decay scheme, half life, method - K-Ar; Rb-Sr; U-Pb, Pb-Pb. Age of the earth. Earth's internal structures and its composition. Evidence for the Earth's composition and mineralogy – 1. Seismic data, 2. Density studies, 3. Meteorites. Earth's internal layers - Crust, mantle and core. Lithosphere, asthenosphere, mesosphere and barysphere.

Unit II GEOMORPHOLOGY – I

Introduction:- Basic concepts of Geomorphology, Definition and scope, Geomorphic agents, Geomorphic processes; endogenetic (epigene) and exogenetic (hypogene). Land forms. Weathering - physical, chemical, biological. Soil - Definition, Formation, Types of soils. Soil Profile. Rivers and fluvial landforms:- Introduction, Development of rivers - Drainage system and patterns. Stages of rivers – Davi's concept; youth, mature, old. Geological actions: Erosion - hydraulic action, abrasion, attrition, solution. Erosional landforms – Pot holes, V shaped valleys, gorges and canyons, waterfalls and types, river meanders, oxbow lakes, river terraces, structural benches. Transportation - suspension, solution. Deposition and depositional landforms - alluvial fans and cones, flood plains, natural levees, deltas, channel deposits. Wind and Aeolian landforms: Types of wind – Breeze, Gale, Tempest, Cyclone. Geological action of wind: Wind erosion - Deflation, abrasion, attrition. Erosional features - mushroom rocks, yardangs, Hamda, ventifacts, pedestal rocks, zeugen, milletseed sands. Transportation - suspension, saltation, traction. Deposition and depositional landforms - Sand dunes and types, Loess.

GEOMORPHOLOGY - II

Glaciers and glacial landforms. Growth and movement of glaciers. Types of glaciers – Mountain or valley glaciers, Piedmont glaciers, continental ice-sheets or ice caps. Glacier imprints. Geological action of glaciers; Erosional work by glaciers – Plucking/ Excavation, Frost wedging, Abrasion. Erosional landforms - Whaleback forms. Glacial valley - U shaped valley and V- shaped valley, Crag and Tail, Hanging valley, Cirques, Fiords, Arete, Cols, Horns, Roches Moutonnes. Transportation – glacial drift. Deposition and depositional landforms – Glacial Moraines and types, Drumlins, Kames, Eskers, Outwash plains, Kettles. Groundwater:- Meaning and components of groundwater. Geological action of groundwater: Erosion and erosional landforms (lapis, solution holes and associated features, poljes, caves and caverns: valleys of karst topography, natural bridges). Transportation; solution. Depositional work; concretions, stalactites and stalagmites, Oceans and Coastal landforms:- Topography of ocean floor – continental slope, shelf, abyssal zone, midoceanic ridges. Geological action of oceans: Agents of coastal erosion; Waves, Tides, Currents and circulation of water. Process of marine erosion, erosional landforms (Headlands and Bays,

Sea Cliffs, Wave-cut Terraces, Sea caves, stacks). Transportation. Depositional landforms (Beaches and barriers, wave built terraces, Spits and bars, Tombola). Deep sea water deposits – terrigenous and pelagic deposits. Corals - its types and origin.

GEODYNAMICS

Introduction to Geodynamics. Origin of oceans, continents and mountains. Concepts and theories of isostasy. Concept of palaeomagnetism, application of palaeomagnetism. Continental drift. Sea floor spreading. Concept of plate tectonics. Nature and types of plate margins, Midoceanic ridges and trenches. Origin and distribution of Island arcs. Earthquakes:- definition, Elements of an earthquake, types of earthquake waves, intensity and magnitude, seismographs and seismometers, causes and prediction of earthquake, Effects of earthquake, Seismic zones of India. Volcanoes:- A typical volcano parts, volcanic activity, types of volcanoes, composition of lava, distribution of volcanoes. Volcanic landforms; depressed landforms: Volcanic cone (Cinder Cone), Volcanic craters, Calderas (Caldera Lake). Landforms due to the accumulation of lava: Volcanic mountains, Volcanic plateaus, Volcanic plains, Volcanic necks.

Crystals, crystalline solids and their formation; Symmetry in crystals; Axial ratio, indices, order of the crystallographic axes; Crystallographic notation (Weiss and Miller indices and convention in notation); Classification of crystals, introduction to 32 classes; The crystal systems and symmetry types; Stereographic representation of crystal symmetry and their uses; Imperfection of crystals and crystal defects; Twinning causes, effects and genetic types Isotropic and anisotropic substances; Reflection, refraction and refractive index; Relief, birefringence and Becke line effect; Optically uniaxial and biaxial minerals; Determination of optic sign of uniaxial and biaxial minerals; interference figures; Pleochroism and determination of pleochroic scheme in minerals; X-ray crystallography and Bragg's equation; Application of X-ray diffraction spectrometry in mineral characterization; Application of techniques in mineralogy: Differential Thermal Analysis (DTA), Thermogravimetric Analysis (TGA), Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Electron Probe Micro Analyser (EPMA); Application of thermal, magnetic and radioactive properties of minerals.

Definition of ore, ore mineral and gangue; Classification of ore deposits; Chemical composition, diagnostic characters, uses and distribution in India of the following minerals: Gold, Copper, Iron, Manganese, Lead, Zinc, Bauxite, Chromite, magnesite, pyrite, diamond, muscovite, beryl, fluorite, gypsum, barite, halite, phosphorite, talc, kyanite, graphite, asbestos, monazite and corundum; Origin, uses and distribution of coal and petroleum in India.

Soil pedological and edaphological concepts. Composition of earth crust and its relationship with soils; Rocks, minerals and other soil forming materials; Weathering of rocks and minerals; Factors of soil formation soil profile, horizons and their nomenclature. Soil texture, textural classes, mechanical analysis, specific surface. Soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage basic concepts.

Soil structure - genesis, types, characterization and management soil structure; soil aggregation, aggregate stability, soil conditioners. Soil water: content and potential, soil water retention, soil-water constants, measurement of soil water content, energy state of soil water, soil water potential. soil classification, soil mineralogy and soil maps – usefulness

Soil Erosion And Conservation: History, distribution, identification and description of soil erosion problems in India. Forms of soil erosion; effects of soil erosion and factors affecting soil erosion; types and mechanisms of water erosion; Soil survey and its types; soil survey techniques - conventional and modern; soil survey interpretations; soil mapping, thematic soil maps Soil conservation planning; soil conservation

in special problem areas such as hilly, arid and semi-arid regions, waterlogged, wet lands and methods (agromorphic, physical and biological methods)

Soil Management: Area and distribution of problem soils - acidic, saline, sodic and physically degraded soils; origin and basic concept of problematic soils, and factors responsible. Morphological features of saline, sodic and saline sodic soils; characterization of salt-affected soils -soluble salts, ESP, pH; physical, chemical and microbiological properties. Management of salt affected soils; salt tolerance of crops – mechanism and ratings; monitoring of soil salinity in the field; management principles for sandy, clayey, red lateritic and dry land soils. Acid soils - nature of soil acidity, sources of soil acidity; effect on plant growth, lime requirement of acid soils; management of acid soils; biological sickness of soils and its management. Reclamation of salt-affected soils; mine land reclamation, afforestation, organic products. Extent, diagnosis and mapping of land degradation by conventional and modern RS-GIS tools; monitoring land degradation by fast assessment, modern tools, land use policy, incentives and participatory approach for reversing land degradation; global issues for twenty first century.

Introduction to Earth Sciences with a special focus to Geology, scope, sub-disciplines and relationship with other branches of sciences Earth in the solar system, origin Earth's size, shape, mass, density, rotational and evolutionary parameters Solar System- Introduction to Various planets – Terrestrial Planets Solar System- Introduction to Various planets - Jovian Planets Internal constitution of the earth - core, mantle and crust Convections in the earth's core and production of magnetic field Composition of earth in comparison to other bodies in the solar system. Origin and composition of hydrosphere and atmosphere Origin of biosphere Origin of oceans, continents and mountains Age of the earth; Radioactivity and its application in determining the age of the Earth, rocks, minerals and fossils

Geohazards: assessment and planning- Introduction, types of hazards; characteristic features, occurrence and impact of different types, Causes and Strategies for Mitigation of Geological Hazards; Risk assessment, Hazard maps, Land-use planning and hazards

Earthquakes, Mitigation Approaches: – Earthquake, its Causes, Specific threats, Community impacts, and Mitigation strategies. Characteristic features; Earthquake Risk Mitigation Magnitude and Intensity of earthquake; Major earthquakes; Seismic zoning; Earthquake vulnerability of India; Earthquake risk mitigation – Seismic performance examination of RCC Buildings, retrofitting of vulnerable buildings, Construction of earthquake resistant buildings following proper BIS codes, Earthquake preparedness; Case study – 'Bhuj Earthquake'. **Volcanic hazard:** Introduction, Types of volcanoes, Volcanic form and structure, Types of central eruption, Causes of volcanic eruptions, Volcanic products: volatiles, Volcanic products: pyroclasts, Volcanic products: lava flows, Specific threats, Community impacts, Volcanic hazard and prediction Mitigation strategies

Tsunami Events, Mitigation Approaches: introduction to Tsunami; Magnitude & Intensity of a Tsunami; Types of Tsunami; Features of **Flood and Mitigation Approaches:** Types of floods, Causes of floods, Specific threats, Community impacts. Mitigation strategies: Floodplain Management, Flood Insurance, Flood Mitigation Programs, Property Acquisitions, Retrofitting Flood Prone Residential Structures **Mass movements:** Soil creep and valley bulging, Causes of landslides, Classification of landslides, Landslides in soils Landslides in rock masses, A brief note on slope stability analysis. Monitoring slopes, Landslide hazard, investigation and mapping, Methods of slope control and stabilization Landslide Specific threats, Community impacts, Mitigation strategies.

Crystal morphology and internal structures. Crystal parameters and indices. Crystal symmetry and classification of crystals into six systems and 32-point groups. Stereographic projections of symmetry

elements and forms. Introduction to analytical techniques like XRD (X-ray diffraction), SEM (secondary electron microscopy). Elements of crystal chemistry and aspects of crystal structures. Minerals: definition and classification, physical and chemical composition of common rockforming minerals. Nature of light and principles of optical mineralogy.

Introduction to the petrological microscope and identification of common rock forming minerals Rock associations in time and space. Physical aspects of magma generation in crust and mantle. Physical properties of magmas; igneous cumulates, liquid immiscibility, pneumatolitic action, magmatic assimilation and mixing of magmas. Textures of igneous rocks. Classification of igneous rocks. Igneous rock associations. Origin, classification and occurrence of sedimentary rocks. Siliciclastic Sedimentary Rocks: Sedimentary textures, Sedimentary structures. Sandstones, Conglomerates, Mudstones and shales. Diagenesis of sandstones and shales, Limestones, Dolomites. Metamorphic rocks- Metamorphism, types of metamorphism, classification of metamorphic rocks, common textures and Structures.

Introduction to minerals and rocks Introduction to rock forming and economically important minerals.

Principles of rock cycle, origin and classification of economically important mineral deposits. Properties of minerals and rocks, and their occurrences: Physical properties, chemical composition, and diagnostic criteria for the identification of minerals. Ore minerals and gangue minerals, tenor and grade of the ore for industrial processing of minerals. Selection criteria followed for quarrying of decorative and dimensional rock blocks/slabs. National mineral policy.

Properties, occurrences and distribution of the following minerals/rocks in India, with special reference to Karnataka: Gold, diamonds, precious minerals, corals, pearl and opals, sapphires, rubies, and emeralds. Chromite, ilmenite, magnetite, hematite, sphalerite, galena, chalcocopyrite, pyrolusite Calcite, lime stone, gypsum, clay minerals, magnesite, graphite, chalk, marble, dolomite, zircon, kaolin, magnesia and alumina minerals, Clay minerals, kaolinite, silica sand and bauxite, limestone and feldspar Industrial diamond, corundum, garnet and quartz magnesite, pumice, and diatomaceous earth Rare earth elements, Ilmenite, monazite, mica, vanadium from magnetite, poly metallic nodules and rock encrustation in the ocean to extract cobalt and nickel. Barite, calcite, magnesite, asbestos, diatomite, feldspar, gypsum, kaolinite, phosphorite, mica, talc, zeolite, bauxite, chromite, ilmenite, magnetite, hematite, sphalerite, galena, clay minerals chalcocopyrite, pyrolusite, pyrite and monazite. Marble, granites, gneiss, dolerite, phyllite, slate, sandstones, sand, gravel, pebble and boulders. Clay minerals, ilmenite, polymorphs of carbon, titanium and anhydrous ironoxide minerals and mineral composite for rare mineral substitutes

Modes of preservation of fossils- Cast, moulds, petrification, coalification, Tracks and Trails, Footprints, Burrowing and Boring. Types of fossils – Index fossil, Synthetic fossil, Persistent fossils Invertebrate and Vertebrate fossils Definition, Classification, and stratigraphic significance of phylum: Mollusca (Pelecypoda, Cephalopoda, Gastropoda) Phylum: Arthropoda, Class: Trilobita Paleobotany and Microfossils classification of plants, plants through geological ages, Gondwana plants, Microfossils- Classification of microfossils. Foraminifera, Ostracoda.

Introduction to Gemology, classification of gemstones, detailed study of different physical characters and Optical properties of minerals with special reference of to gem minerals. Physico-optical effects in gem stones. Colour and cause of color in gems. Cutting and polishing of gemstones. A detailed study of important precious and semi-precious gem minerals- their characters and occurrences- world occurrences in general and Indian occurrences in particular. Precious Varieties: 1. Diamond, 2. Ruby, 3. Sapphire, 4. Topaz, 5. Emerald ii) Semi-Precious varieties: Garnets, Quartz, Lapis lazuli, Turquoise and Organic gems. Ornamental stones:

Introduction to petrology, Classification of rocks, Properties of Igneous, Sedimentary and Metamorphic rocks. Suitability of rocks for ornamental purposes. Occurrence and distribution rocks in Indian sub-continent with particular reference to Karnataka. Evaluation, Quarrying, cutting and polishing of rocks.

Principles of Stratigraphy: Concepts in stratigraphy: Basic principles and definitions, Concept of facies, Walther's Law of facies succession. Stratigraphic classification and code of Stratigraphic nomenclature, Stratigraphic correlation. Brief description of principal stratigraphic units: Lithostratigraphy, Biostratigraphy, Chronostratigraphy. Standard Geological time scale.

Palaeontology: Introduction to palaeontology. Definition and classification of fossils. Types of fossils and fossilization – Modes of Preservation- Fossils of soft parts, fossils of hard parts (unaltered hard parts, altered hard parts (Molds & Casts, Petrification: Permineralization & Replacement, and Carbonization) and indirect fossils (Imprints, Traces of Biological Activity: Tracks, Trails and Burrows – Ichnofossils).

Significance of fossils.

General classification, morphological characters, distribution and geological History of Following Invertebrate Fossils: Coelenterata, Graptolites, Brachiopods, Lamellibranchia, Cephalopods, Echinodermata, Arthropoda. Classification of Microfossils, Morphology, classification and evolution of foraminifera. A brief study of vertebrate life through ages.

Plant fossils through ages. Gondwana flora and their significance.

Geology of India

Physiographic divisions of India: Brief Introduction to the physiographic and tectonic subdivisions of India
Archaean and Proterozoic Formations of Peninsular India – distribution and classification concerning Karnataka. Sargur Group, Dharwar Super Group, Peninsular Gneiss. **Proterozoic:** distribution, classification and economic importance of Cuddapah and Kaladgi, Vindhyan, Bhima and Kurnool Groups.

Paleozoic Group: Paleozoic rocks of the Spiti. **Mesozoic:** (i) Triassic successions of Spiti, (ii) Jurassic of Kutch, (iii) Cretaceous successions of Cauvery basins **Cenozoic stratigraphy of India:** (i) Kutch basin, (ii) Siwalik successions, (iii) Assam, Andaman and Arakan basins.

Volcanic provinces of India: Deccan traps: Distribution, lithology and biostratigraphy, classification, intertrappeans, intratrappeans, infratrappeans, Bhag beds and lameta beds, age of Deccan traps, economic

importance of Deccan traps. Rajmahal, Sylhet Trap Siwaliks – lithology, distributions, classification, life and age.

Stratigraphic boundaries: Important Stratigraphic boundaries in India- a. Precambrian-Cambrian boundary, b. Permian-Triassic boundary, and c. Cretaceous- Tertiary boundary.

Introduction: General, legal and Leasing Policy, Exploration of Resources, Estimation of Reserves, Classification of dimensional stone based on Grade, hardness and quality factors, Quarrying Techniques, Processing Units, commercial values, Marketing, etc.

Geology and Exploration:

General, Dimensional Stone Reserves in India, Geology and Geographical distribution of Marble, Granite, Sandstone, Limestone, Slate Deposits, soap stone, dolerite, basalt, Laterite with special reference to Karnataka. Prospecting and exploration of dimensional Stone deposits, Reserve Estimation, Evaluation parameters.

Characterization of Dimensional Stone: Introduction, Petrography Examination, chemical and mineralogical composition, Physico-mechanical Properties,

Mining of Dimensional Stone:

General, Stages – Over burden removal, primary cutting, manual operation, Semi - mechanized operation - line drilling machines. Mechanized operations- Plane cutting, water jet cutting, splitting method, Hydraulic splitting, Conventional Mining of Limestone (Kotah stone), Sandstone, Granite and Marble. **Specification and tests** – Indian standard BIS and International Market ASTM .

Processing: General, Flow chart of Processing; Dressing, Cutting/Sawing, Surface Grinding and Polishing/Flaming, Edging/Trimming/Grooving, Gang Saw, Circular Saw, Various types of Polishing Machines.

Abrasives: Types, Use and Selection, Shaping. **Dimensional Stones:** Uses, Marketing and Environmental impacts of Stone Industry.

Oceanography - Physical properties of sea water, waves, tides and currents, Composition of sea water and processes controlling it. Food-web, primary, secondary and tertiary production. Classification of marine life, planktonic and benthic life in the ocean.

Geological oceanography: Morphology of Ocean floor, Origin and evolution of the ocean basins. Continental drift, Sea-floor spreading and plate tectonics.

Marine mineral resources: Distribution and classification of minerals of economic importance in different oceanographic settings: Sea water as sources of elements/minerals. Placer and heavy mineral deposits, petroleum and coal, phosphorites, gas hydrates, poly-metallic nodules, hydrothermal and metalliferous sediments.

Meteorology

Elements of meteorology and their significance. Temperature, atmospheric pressure and air masses, wind, humidity, clouds precipitation (rainfall). Earth's radiation balance and human interference: Meteorological hazards: floods, drought, famine, cyclones, cloud burst, thunder storms, dust storms and hailstones. General weather system of India. Monsoons, their seasonality, onset and withdrawal, causative factors and trends. A brief introduction to Satellite Meteorology and its applications.

Climatology

Principles of climatology and differences between meteorology and climatology. Climate of the globe and its classification. Climate Change: short-term and long-term climate cycles. Classification of continental and oceanic climates: Greeks, Koppen's and Thornthwaite's schemes of classification.

Paleoclimatology:

Tracers or proxies for understanding the long-term paleoclimate. Archives of paleoclimate: ice cores, tree

Watershed—definition, concept, objectives, Land capability classification, priority watersheds, land resource regions in India. Watershed Planning – Principles, collection of data, present land use, Preparation of watershed development plan, Estimation of costs and benefits, Financial plan, selection of implementation agency, Monitoring and evaluation system.

Watershed management: Participatory watershed Management, run off management, factors affecting run off, Temporary & Permanent gully control measures, Water conservation practices in irrigated lands, Soil and moisture conservation practices in drylands.

Water conservation practices: *In-situ* & *Ex-situ* moisture conservation principle and practices, Afforestation principle, Microcatchment water harvesting, Groundwater recharge, percolation ponds, Water harvesting, Farmpond, Supplemental irrigation, Evaporation suppression, Seepage reduction.

Watershed Development Programme: River Valley Project (RVP), Hill Area Development Programme

(HADP). National Watershed Development Programme for Rain fed Agriculture (NWDPR), Other similar projects operated in India. Govt. of India guidelines on watershed development programme, Watershed based rural development, Infrastructure development, Use of Aerial photography and Remote sensing in watershed management. Role of NGOs in watershed development.

Structural Geology: Introduction. Structural Forms of Rocks: Primary Structural Forms & Secondary Structural Forms. Concept of brittle and ductile deformation. Forces – compression, tension, torsion and shear.

Primary structural forms—Sedimentary and Igneous Rocks. Lineation, Foliation and Unconformity. Description and origin of foliations: axial plane cleavage and its tectonic significance. Description and origin of lineation and relationship with the major structures. Unconformity types – para, dis, non, angular and regional unconformities.

Secondary structural forms: *Cohesive Dislocations* –Distortion, bending and Folds. Folds: Definitions - parts of folds, axis, axial planes, limb, plunge. Crest and troughs. Mechanics of folding: Buckling, Bending, Flexural slip and flow folding. Types of folds – symmetrical and asymmetrical –anticline, syncline, anticlinorium, synclinorium, overturned fold, recumbent fold. isoclinal, chevron, fan folds, monocline and drag folds. Denudational structures – Outlier and inlier.

Disruptive Dislocations – Joints and Faults. Joints: Definition, Dip, Strike. Joint plane, block Joint, Joint set, Joint system. Classification – I. Geometrical: Dip, Strike, Oblique and bedding joints. II. Genetic – columnar, mural sheet joints, Master joints. Importance of joints.

Fractures and Faults: Definition-Elements of fault, Fault planes, Dip, Strike, Hade, Heave and Throw. Hanging and footwalls. Classification – I. Geometrical: a) Based on attitude of faults as compared to the adjacent beds. Dip, Strike, Diagonal and Bedding faults. b) Based on Apparent movement, normal and reverse faults. II. Genetic: Thrust faults, over thrust, and under thrust. Gravity faults - Step fault, Ridge fault. Trough faults. Criteria for recognition of faults in the field.

Hydrogeology: Introduction and basic concepts. Scope of hydrogeology and its societal relevance Hydrologic cycle. Precipitation, evapotranspiration, runoff, infiltration and subsurface movement of water. Rock properties were affecting groundwater, Vertical distribution of subsurface, types of the aquifer, aquifer parameters, anisotropy and heterogeneity of aquifers. Groundwater flows under Darcy's law and its validity, intrinsic permeability and hydraulic conductivity, Groundwater flow rates and flow direction, and Laminar and turbulent groundwater flow. Well, hydraulics and Groundwater exploration, Basic Concepts (Drawdown, specific capacity), and Elementary concepts related to equilibrium and Nonequilibrium conditions for water flow to a well in confined and unconfined aquifers. Surface-based groundwater exploration methods, Introduction to subsurface borehole logging methods.

Groundwater chemistry: Physical and chemical properties of water and water quality, Introduction to methods of interpreting groundwater quality data using standard graphical plots, Seawater intrusion in coastal aquifers. Groundwater management, Surface and subsurface water interaction, Groundwater level fluctuations, and Basic concepts of water balance studies. Rainwater harvesting and artificial recharge of groundwater.

Geological History of mineral evolution; Critical minerals for economic growth; rare earth elements and their uses in modern technology for low carbon economic growth. Water-Future: ground water exploration and exploitation, recycling water and pollution monitoring and water management.

Desalination of coastal region water to improve the water quality. Understanding of hydrogeology and environmental conditions for water management.

Engineering geology for construction of earthquake resilience infrastructure for public; micro-zonation studies of seismic hazards analyses of smart cities, dams and nuclear power stations.

Understanding the basics of past climate change through field work near ancient stalagmites bearing caves to provide basic parameters for future Earth. Thermodynamic modelling of carbon capture and sequestration using naturally occurring minerals. Modelling of probable risks of natural hazard and climate change with precise uncertainties.

Physical properties of the Earth, Scope of exploration geophysics, Geophysical survey methods, Uses of geophysical Surveys, Geophysical surveying applications Electrical and Electromagnetic Methods *Electrical methods*: Introduction, Electrical methods – Self-Potential, Induced Polarization, Electromagnetic and Resistivity methods, Methods of electrode arrangement, Field methods, Data Interpretation and Application, *Electromagnetic methods*: Principle, Field procedure, Magnetometers, Interpretation of magnetic data, Size and shape of bodies, Correction of magnetic data, Applications.

Gravity and Seismic Methods *Gravity Methods*: Principle, Units of gravity, Measurement of gravity, Gravity anomalies, Field methods, Gravimeters, Corrections, Interpretation of gravity data, Determination of shape and depth of ore bodies, Corrections and applications. *Seismic Methods*: Seismic waves, Travel velocity in various geological formations, Principles offshore and onshore field operation, refraction and reflection survey, Correction of seismic data, Methods of interpretation, Types of seismic shooting and Application Airborne and Subsurface Geophysical methods *Airborne Geophysical methods*: Scope of Airborne Investigations, Airborne Geophysical Measures. *Subsurface Geophysical methods*: Introduction to drilling and logging, Principles of well logging, Formation evaluation, Resistivity logging, Self-potential logging, Sonic logging and Application.

Geodiversity and rarity of geological features, Geo-conservation, Geo-site, Geo-heritage and Geopark and their role in geo-tourism development. Concept of National Parks of geological origin. Natural and cultural landscapes, A geo-conservation plan for geosites and the development of UNESCO's Global Geopark. Geotourism - impacts and other types of tourism. Geodiversity values and threats, Geo-tour guides and basic knowledge of geodiversity. Important Geosites of India and in particular Karnataka, Geotourism Development & Sustainable Management, Education on Geosites preservation. Locations of important fossil parks in India – Marine Gondwana Fossil Park, Fossil Wood Parks, Siwalik Fossil Park, Stromatolite Parks, etc. Rock monuments of India – Peninsular Gneiss, Columnar Basalt, Pillow Lava, Pyroclastic Rocks, Nepheline Syenite, Barr Conglomerate, Welded Tuff, Charnockite. Geological Marvels – Lonar Lake, Eddy Current Markings, Natural Arch, Wind erosion structures, Sendra Granite, etc. Other monuments – stratigraphic and economic important locations/ mines. Natural caves and tunnels, Stalactites and Stalagmites.

ORE GEOLOGY

Introduction to ore geology in relation of industry, commerce and national economy. Ore minerals. Gangue minerals, Tenor of ore. Economic Minerals – Strategic, Critical and Essential minerals Principles and Processes of Ore formation: Magmatic processes: Early magmatic deposits: Dissemination, Segregation and Injection deposits. Late magmatic deposits: Residual Liquid Segregation, Residual Liquid Injection, Immiscible Liquid Segregation, Immiscible Liquid Injection. Contact metasomatism: Skarn deposits. Hydrothermal processes: Hydrothermal fluids and their migration and deposition. Cavity filling

and Replacement deposits. Sources of solutions and their contents, Means of transport. Weathering processes: Residual, mechanical concentrations (placers) - Eluvial, Stream and Marine Deposits. Sedimentation: Fe and Mn cycles.

Oxidation and supergene enrichment: Gossans. Metamorphism: Metamorphic deposits – Asbestos, Garnet, Al- Si minerals like kyanite, sillimanite and staurolite Classification of ore deposits - Jenson and Bateman. Metallogenic Epochs and Provinces. Metallogeny in relation to plate tectonics.

INDIAN MINERAL DEPOSITS

Metallic Mineral Resources: Introduction, Study of the following deposits of India with special reference to Karnataka with regards to their mineralogy, origin, occurrence and distribution: Gold (Kolar, Gadag, Hutti), Copper (Ingaldhal, Kalyadi, Thintini), Iron (Chikamagalur, Bellary, North Kanara), Manganese (Shivamogga, North Kanara, Sandur, Tumkur), Aluminium (Boknur-Navge, Paduware, Bababudan). National Mineral Policy: Major and minor minerals

Non-metallic Mineral Resources: Introduction, Study of the following deposits of India with special reference to Karnataka with regards to their mineralogy, origin, occurrence and distribution: Mica - Bihar mica belt, Nellore mica belt, Andrapradesh. Mica deposits of Rajasthan. Abrasives - Natural abrasives - *High grade natural abrasive*- Diamond, Corundum, Garnet Siliceous abrasives: Grindstones and millstone, Flint, Sandstone, Quartzite, Miscellaneous abrasives: Calcite, Feldspars, Fuller's earth, Magnesite, Soapstone, and talc. Refractories - Principal varieties of refractories, Classification of refractories. Fire clays refractories, Silica refractories, High alumina refractories, Magnesite refractories, Chromite refractories, Zirconia refractories. Building and Ornamental stone:Granites, Dolerite, Sandstone, Basalt, Limestone, Marbles, Laterite, Slate, Soapstone. Glass and ceramics:Quartz, Clay, Feldspar, calcite Fertilizer minerals: Gypsum, Phosphate (apatite), Rock Phosphate (Phosphorite), Potash, Pyrite and sulphur. Definitions of the term's ore grade and Reserve. Assessment of grade. Reserve estimation

FUEL GEOLOGY

A brief introduction on coal, petroleum, gas hydrates and nuclear fuel. **Coal** – Definition of coal, types, stages and periods of coal formation (Gondwana, Tertiary and Cretaceous coals), Chemical composition, Properties of coal, Seyler's classification of coal, Origin, Accumulation and distribution of Coal deposits of India including Peat and lignite deposits. Methods of mining coal. Coal as a fuel: Coal Bed Methane (CBM): global and Indian scenario, Underground coal gasification, Coal liquefaction. Briefly discuss the coal deposits of India with reference to geology, origin and distribution of Singrauli Coalfield, Jharia Coalfield and Godavari valley coalfield. **Petroleum** – Introduction, elemental analysis of crude oil, chemical composition and physical properties of crudes innature. Occurrence, accumulation and origin. Formation of Source Rocks. Maturation of kerogen: Biogenic and Thermal effect. Migration.Petroleum Reservoirs and Traps: Reservoir rocks: general attributes and petrophysical properties. Classification of reservoir rocks - clastic and chemical. Hydrocarbon traps: definition, anticlinal theory and trap theory. Classification of hydrocarbon traps – structural (Anticline, Fault traps & Salt Domes), stratigraphic and combination. Cap rocks - definition and general properties. Distribution of On-shore and Off-shore oil fields of India.Briefly discuss the oil deposits of India with reference to Geology, origin. Occurrence and distribution of Digboi oil field, Mumbai High and Ankleshwar oil field.

Remote Sensing

Aerial Remote Sensing: Definition and scope of remote sensing in natural resources survey. Aerial Photography: Scale, sidalap overlap, drift and crab.Photographic flight mission;purpose, area, scale, aerial cameras and lens, flight direction, Time of photography, season of photography,overlaps.Typesofaerialphotography: Classification, vertical, oblique,high oblique stereoscopy:A brief introduction of viewing, measuring and plotting instruments. Viewing instruments lens and mirror stereoscopes. Preparation of Photo-Geological map- Mosaics and its types, photo

interpretation and annotation, preparation of final photogeological map.

Elements of aerial photo interpretation: photographic tone, texture, shape of objects, size of objects, patterns, scale.

Satellite Remote Sensing: Principles of Remote sensing, stages in remote sensing. Electromagnetic radiation - characteristics of electromagnetic spectrum; interaction of EMR with the earth's surface (reflection, surface roughness, transmission, spectral signature) and with the atmosphere (scattering, absorption, atmospheric windows, refraction, atmospheric haze). Platform, sensors, resolution, multispectral scanners- across-track and along track multi spectral Scanning, data reception and product generation. Microwave remote sensing: SLAR&SAR. Application of remote sensing in geosciences and geomorphological studies.

Geographical Information System and Its Application: Introduction to GIS. Map projection and its types - Cylindrical, UTM, Conical and Azimuthal, selecting suitable map projection. Representation of earth features in GIS: point, line, polygon. spatial data and attributes. Components of GIS: GIS infrastructure input and output devices. GIS software's -Computer fundamentals of GIS. Data for GIS: layers in GIS. GIS techniques and nature of Data :spatial and a spatial data, temporal data. Data structures - Raster and vector data structures. Advantages and disadvantages of raster and vector data models. Raster data input and Vector data input, applications of GIS Fundamentals of Global positioning System Introduction of Global Positioning System, Satellite constellation, GPS signals and data, Geo-Positioning-Basic Concepts. Discussion on NAVSTAR, GLONASS, GALLILEO, COMPASS Basic geodesy, Coordinate Systems, Special Referencing system, Map Scale, Scale factors, Indian geodetic System

Segments of GPS: Control Segment, Space Segments, User Segment -operations of GPS, accuracy, error sources and analysis, methodology for collection of data, adjustment computations and analysis. Selection of datum, units and scale; GPS measurement. GPS Positioning Types- Absolute Positioning, Differential positioning Methods Application of GPS in Surveying and Mapping, Navigation, Military, Location Based Services, Vehicle tracking, etc. Limitation of GPS & DGPS

MARINE GEOLOGY

Introduction. Morphology and physiographic features of the ocean floor. Classification of sub marine topography. Physico-chemical characteristic of sea water - distribution of temperature, salinity and density of sea water. Waves, Tides, Currents- its types, distribution and their significance. Ocean deposits- source, nature and distribution of marine sediments. Marine resources- type of marine resources and their distribution and utilization, marine mineral resources, marine energy resources and manganese nodules, methods of its exploitation. Sea level changes and impacts.

EXPLORATION GEOLOGY

Introduction to Prospecting and Exploration. Classification of Prospecting methods Principles of Exploration: Geological, Geophysical and Geochemical Methods. Geological Exploration: Geological methods: River float tracing and panning. Guides and criteria for locating ore deposits. Guides: Geological and Non-geological guides. Primary and Secondary dispersion haloes, Gossans, Old workings. Criteria: Stratigraphic, lithological, structural, geomorphological, paleogeographic and paleoclimatic Criteria. Preliminary and detailed exploration, exploratory works – drilling and core logging.

Exploratory grids. Sampling methods. Economic evaluation of mineral deposits based on UNFC classification.

Geochemical Exploration and Bio-Geochemical Exploration: Introduction, Geochemical Cycle – Deep seated & surficial, geochemical mobility of elements. Pathfinder elements. Threshold values and geochemical anomaly. Dispersion – Primary & secondary. Litho geochemistry, soil metallometry, stream sediments, Hydrochemical, Atmochemical and Biogeochemical methods, Geobotany.

GEOPHYSICAL EXPLORATION

Introduction. Methods of Geophysical exploration. Gravity Method: Introduction, basic principle, gravity of the earth, gravity reductions, densities of rocks and minerals, density estimates from field results,

Gravimeters-Stable type, field operations, results and interpretation. Numerical problems on vertical component, gravity gradient and gravity curvature. Magnetic Method: Introduction, Basic principle, Magnetism of the Earth, Magnetism and magnetic susceptibilities of rocks and minerals, Field instruments, field operations. Results and interpretation. Numerical problems on vertical and horizontal components. Seismic Methods: Introduction, principles of reflection and refraction methods, field equipment's – Geophones, results and interpretation. Numerical problems on reflection and refraction methods. Electrical Methods: Introduction, electrical properties of rocks and minerals. Resistivity method: Elemental theory, resistivity meters, electrode layouts – Wenner and Schlumberger spreads, Field procedure, Application of resistivity method in ground water search.

MINING GEOLOGY

Introduction. Mining methods – surface, underground and Oceanic Mining terminologies: Shaft, adits, rise, winze, tunnel, crosscut, veins, hanging and foot walls. Surface mining methods including strip mining, open pit mining, hydraulic mining and dredging. Mine planning. Design criteria for surface mines including scheduling, material removal and capacity-rated equipment- sizing, availability and utilization calculations, slope design, stripping ratio, pit ramp and waste dump design, pit dewatering and land reclamation. Capital and operating cost estimation. Underground Mining Methods and Design: Description and usage of the following underground mining methods: room and pillar, long-hole, longwall, open stoping, shrinkage, cut and fill sub-level stoping, timbered stoping, top slicing, underhand and overhand stoping, block caving, sublevel caving, and vertical crater retreat. Requirements for development and services including shafts, hoists, ramp and multi-level access design. Design of pumping, ventilation, compressed air and power facilities. Underground design including stope development, haulage systems, backfill, equipment selection, and scheduling of development and operations. Capital and operating cost estimation associated with underground mining activities.

Mining and Environment

Environmental practices in mining including waste rock and tailings disposal systems; prediction/prevention/treatment/control of acid rock drainage; control of dust/noise/gaseous emissions; environmental effects monitoring (surface water and groundwater); reclamation and decommissioning; government regulations relating to environmental protection in design/operation/closure of mines; sustainable development principles and application to mining; risk assessment and management principles with respect to the environment.

MINERAL DRESSING: Definition and Scope of Mineral dressing, Physical and Chemical Properties of minerals made use of in Mineral dressing. Comminution: Principles, theories of Comminution, ore grindability. Crushers: Primary and Secondary Crushers. Grinding Mills (Tumbling Mills):- types of Mills : Rod, Ball and Autogenous mills. Industrial Screening: Screens and their types. Classification: Types of classifiers. Gravity concentration: principles. Types of Gravity separators; Heavy Medium Separation - Separating Vessels. Magnetic Separation: Types of Magnetic Separators. Froth Flotation technique of Separation of Complex Sulfide ores: Reagents : Collectors, Frothers and Regulators - Activators & Depressants..

ENGINEERING GEOLOGY:

Introduction: The role of geology in civil engineering. Engineering properties of rocks –Building stones and road materials. Building stones of India- Granite, basalt, sandstone, shale, marble, charnockite, and laterite. Soil: Soil profiles. Structure and texture of soils. Physical and chemical properties of soils. Classification of soil particle size.

Gravitation sloping processes: Classification and description of modern gravitational processes based on type of movement-Slides, falls and flows. Causes of landslides. Subsidence- Carbonate dissolution in the subsurface, subsidence caused by human activities- underground mining and withdrawal of ground water.

Stability of rock slopes and cutting in rocks: Classification of slopes- stable and unstable slopes- Geological parameters. Measures for stabilization of slopes. Cuttings in rock slopes cut design and geological parameters.

Building sites: Requirements, foundation problems, ground conditions, building foundations in bedrock ground, soil, sloping ground.

GEOENGINEERING STUDIES

Bridge sites: Bridge structure, types, bridge problems, and geological parameters. Geology of bridge sites.

Dams and reservoirs: Types of Dams: 1. masonry or concrete dams- gravity, arch and buttress. 2. Earth Dams and 3. composite dams. Location of dam. Geological considerations- topography, structure and lithology. Foundation and seepage problems in dams and their treatment. Foundation treatment; Grouting, Rock Bolting and other support mechanisms. Reservoir: Reservoir problems seepage and silting.

Tunnels: terminology, definitions, types- hard rock and soft rock tunnels. Geological considerations- Lithology and structure. Ground failures in tunnels. Concrete aggregate sources, alkali-aggregate sources, alkali aggregate reaction. Geological site investigations for engineering projects. Aseismic designing and earthquake resistant structures.

Geochemistry

Introduction. Geochemical environment- Deep seated and Surficial, Crustal abundance of chemical elements. Soil chemistry. Phase diagrams. Geochronology – Radio activity, decay schemes, Radiometric dating. Radiogenic Isotopes: strontium isotopes and neodymium isotopes, Application of radiogenic isotopes : K-Ar, U-Pb, Rb-Sr and Sm-Nd, Carbon isotopes.

DISASTER AND NATURAL HAZARDS MANAGEMENT.

Disaster Management: Disaster Terminology – Disaster, Risk, Hazards and vulnerability, vulnerability types, disaster preparedness, interventions in a disaster situation – relief, rehabilitation, disaster mitigation. The disaster management cycle. Disaster Management. objectives and priorities. Efforts to mitigate disasters worldwide – International cooperation. Disaster Management System in India Disaster Management Plans at various Levels. Preparedness Types of Disasters. Nodal Ministries at Central Level Local Level Risk Management GIS & Remote Sensing for Natural Disaster Management. Hazard zonation maps. Natural Hazards Management Earthquakes – Measures for earthquake risk reduction; Pre, medium term and post disaster preventive measures, Consolidation, and reconstruction. Floods – Mitigation; structural & non-structural groups, Preparedness, Response Mechanism, Damage Assessment, Post flood Management Drought – Introduction, Types, Identification of Drought affected areas, Drought Management Landslides – Mitigatory measures, Settlement policy Avalanches – Avalanche Control Measures Coastal erosion and mitigatory measures. Introduction to groundwater exploration. Aquifer and its types. Confined, Unconfined, aquitard, aquifuge, aquiclude, aqueduct. Geological features in the search of groundwater - Topography, climate and vegetation, Geology of the area. Porosity, permeability, joints and faults, folds. Proximity of any tank, reservoirs, existing wells in the vicinity. Areas and elements favorable for groundwater recharge. Dousing Methods. Geophysical exploration of groundwater by resistivity method: introduction, principle, Wenner and Schlumberger method, field procedure - profiling, Depth sounding, interpretation of the data. Well logging, hydro-fracture technique. Profiling in the search of subsurface structures. Introduction, Definitions of GIS and Related Terminology, The Evolution of GIS, Components of GIS, Approaches to the Study of GIS, types of map projections and Principles of GIS. Vector data: point, Line, Area, Surface, Entity, Object, Symbol, Entity relationship model, Real world to map, representation of real world and entities on a map, Spaghetti structure and topological data structure. Raster data: Raster structure, attribute classification, runlength encoding, scan order for Raster, Region quad trees and octrees, lines and points in Raster. Types of Data storage. Introduction,

Overview of image processing software and GIS softwares (ERDAS, Mapinfo, ArcGIS, Arcview, Google Earth).