Annexure- A

Syllabus of Part II of 'Objective Type Multiple Choice Question Paper' carrying **70 Marks** for the posts of (i) **Emergency Operation Centre Incharge-cum-Documentation Coordinator** (Class-II) **and** (ii) **Training Capacity Building Coordinator** (Class-II) which shall be of **02 hours** duration and cover the following topics of Master Degree in (Disaster Management) level & Graduate Diploma in (Disaster Management) level.

1. **NATURAL HAZARDS AND DISASTERS:-**

Concept of Natural Hazards and Disasters, Catastrophes in Nature: Types of Natural Hazards and Disasters, Predicting Catastrophe and Interconnections Among Natural Hazards, Earthquake and Tsunami, Landslide and Avalanche, Volcanic Eruption, Floods and Cloudburst, Cyclone and Associated Hazards, Drought and Desertification, Regional Dimensions of Hazards/Disasters in India, Geo-tectonic Hazards in India: Earthquakes and Landslides, Hydro-meteorological Hazards in India: Floods and Drought, Concept of Natural Hazards and Disasters, Catastrophes in Nature: Types of Natural Hazards and Disasters, Predicting Catastrophe and Interconnections Among Natural Hazards, Earthquake and Tsunami, Landslide and Avalanche, Volcanic Eruption, Floods and Cloudburst, Cyclone and Associated Hazards, Drought and Desertification, Regional Dimensions of Hazards/Disasters in India, Geo-tectonic Hazards in India: Earthquakes and Landslides, Hydro-meteorological Hazards in India: Floods and Drought.

2. **HUMAN MADE HAZARDS AND DISASTERS:-**

Understanding Human-made Hazards and Disasters, Linking Development, Environment and Disasters, Disasters and Impact on the Environment, Public Health Emergency and Disaster Management, Biological Disasters, Epidemics and Health Hazards, Linking Development and Extremism; Terrorism and Security Issues, Industrial & Technological Disasters, Chemical Disasters and Management, Nuclear and Radiological Emergencies, Air, Water and Soil Pollution, Fire; Coal Fire, Forest Fire, Oil Fire, Local Disasters (Road, Rail, Air and Sea Accidents).

3. **FUNDAMENTALS OF GEOINFORMATICS:-**

Fundamental concepts of Remote Sensing: Remote Sensing: Concept, Types and Applications, Remote Sensing Platforms, Sensors and Scanning Systems, Major Satellite Systems and their Sensors, **EMR Principles and Interaction Mechanisms:** Electromagnetic Spectrum; Energy-Atmosphere Interaction**,** Energy-Earth Interaction; Spectral Signatures of Surface Features**,** Image: Meaning and Types and Characteristics, **Fundamentals of Geographic Information Systems:** Definition, Concept, Significance, Component and Applications of GIS**,** Spatial data base: Types and Representations**,** GIS Analysis: Buffer, Overlay and Query, **Fundamentals of Global Navigational Satellite System:** Global Navigational Satellite System and its Application**,** GPS Concept and Principles of Operation, GPS Segment**,** GPS Positioning, GPS Accuracy and Errors, Major GPS Systems.

4. **GLOBAL INITIATIVES FOR DISASTER MANAGEMENT AND DISASTER MANAGEMENT MECHANISMS IN INDIA:-**

Global Disaster Scenario: Emergence and evolution of disaster research and management, Global Disasters: Continental disaster profiling, Country-wise disaster profiling with special focus on Asian countries, **Global Initiatives for Disaster Management:** IDNDR: Formulation, Priorities and Outcomes**,** ISDR: Formulation, Priorities and Outcomes**,** Hyogo Framework (HFA): Framework, Priorities for Action and outcomes, **Contemporary Disaster Management Framework and Future Agenda:** Sendai Framework: Goals, objectives and Guiding Principles**,** Priorities for Action in Sendai Framework**,** Sendai Framework: Role of Stakeholders; International Cooperation and Partnership, **International Agencies for Disaster Management:** United Nations: FAO, IOM, UNDP, OHCHR, UNHCR, UNICEF, WFP, WHO**,** IFRC and ICRC**,** International Non-governmental agencies, Disaster-scope of India, Role of Planning Commission in Disaster Management, disaster Management Act, 2005, Disaster Management Plan and Policy, Institutional Framework for Disaster Management, Financial Framework for Disaster Management, Legal Framework for Disaster Management, Role and Responsibilities of NDMA, SDMA, DDMA, Role of NIDM, SIDM, NDRF, SDRF, Role of Municipalities and Panchayati Raj Institutions in Disaster Management, Community Participation in Disaster Management and Risk Reduction.

5. **DISASTER RISK REDUCTION AND MANAGEMENT PLANNING:-**

Disaster Risk Reduction: Disaster Risk: Concept and Components, Disaster Risk Reduction (DRR) Concept and Relevance, DRR Activities and Initiatives; Disaster Risk Management (DRM), **Community Based Disaster Risk Management (CBDRM):** Resilience, Community, Characteristics Disaster Resilient Communities**,** Concept, Need, Relevance and Approaches of CBDRM**,** Integrating Disaster Risk Reduction with Rural Development, **Public Preparedness and Management for Risk Reduction:** Public Awareness and Preparedness for Risk Reduction**,** Mock Drills, School and Hospital Safety, Crowd Management**, Developing Disaster Risk Resilience for Urban Cities:** Media in Public Preparedness, Awareness and Risk Reduction**,** Role of NGOs and Corporate Sector in Disaster Risk Management**,** Gender-Sensitive Disaster Risk Reduction.

6. **DISASTER PREPAREDNESS:-**

Introduction to disaster Preparedness: Disaster Management: Prevention, Preparedness and Mitigation**,** Disaster Preparedness: Concept & Nature**,** Disaster Preparedness Plan**,** Disaster Preparedness for People and Infrastructure**,** Community based Disaster Preparedness Plan**, Roles & Responsibilities of Different Agencies and Govt.:** Roll of Information, Education, Communication & Training**,** Role and Responsibilities of Central, State, District and local administration, Role and Responsibilities of Armed Forces, Police, Para Military Forces, Role and Responsibilities of International Agencies, NGO's, Community Based Org. (CBO's)**, Technologies for Disaster Management:** Role of IT in Disaster Preparedness**,** Remote Sensing, GIS and GPS**,** Use and Application of Emerging Technologies**,** Application

of Modern Technologies for the Emergency communication, Application and use of ICST for different disasters, **Disaster Mitigation:** Disaster Mitigation: meaning and concept**,** Disaster Mitigation Strategies**,** Emerging Trends in Disaster Mitigation**,** Mitigation management**,** Role of Team and Coordination.

7. **REHABILITATION, RECONSTRUCTION AND RECOVERY:-**

Reconstruction and Rehabilitation as Means of Development, Damage Assessment, Role of various Agencies in Disaster Management and Development, Information Management Structure, Development of Physical and Economic Infrastructure, Creation of Long-term Job Opportunities and Livelihood Options, Funding Arrangements for Reconstruction, Nature of Damage to Houses and Infrastructure due to Disasters, Disaster Resistant House Construction, Role of Housing/ Building Authorities, Education and Awareness, The Philosophy of Coping with Disasters, Dealing with Victims' Psychology, Role of Information Dissemination, Participative Rehabilitation Process: Some Case Studies, Role of Various Agencies in Recovery Measures, Monitoring and Evaluation of Rehabilitation Work, Constraints in Monitoring and Evaluation, Long-term Recovery, Long-term Counter Disaster Planning.

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1. GEOMORPHOLOGY:-

Geomorphology: Meaning, nature and scopes, approaches of geo morphological analysis, Fundamental concepts in geo morphology: geological structure and landforms, uniformitarianism, characteristic assemblages of landforms, sequential changes in landforms, Structural geomorphology: Physical conditions of earth interior, characteristics and topographic expression of fault and fold structures, Mountain and mountain building theories by Kober and Holmes, Forces of crustal instability: Continental drift and Plate Tectonics, Isostasy, Vulcanicity, Weathering and mass wasting: meaning, significance, controlling factors and classification. Concept of Hill-slope development, Slope decline theory by Davis, Slope replacement by Penck and parallel retreat by King, Drainage system and pattern, concept of river capture, man and river processes, Surface processes and landforms: Fluvial geomorphic system and its evolution, Aeolian processes and landforms, glacial processes and landforms, Karst process and landforms, workof ocean and coastal landforms, Concept of Applied Geomorphology: Geomorphology and Hazard management, Geomorphology and Urbanization, Geomorphology and Hydrology.

2. HUMAN GEOGRAPHY:-

Human Geography: Changing Scales of Experience: Meaning of Human Geography, Subject Matter of Human Geography, Human Geography through the corridors of time, Classification of Human Societies, Man- Environmental Relationship and Environmental Crisis**, Urbanism, Globalization and Changing Culture:** Defining Urban area: Town and City, Origin and Growth of Urbanization in India. Concept of Globalization, Cultural globalization, Impact of globalization on Indian culture, **Population and Food Supply and Ageing:** Population Growth and Food Supply, Demographic transition model and Emergence of second demographic transition, Population Ageing and development**, Geopolitical Traditions, Development and Sustainability:** Organic Theory of State, German Geopolitics, Heartland and Rimland Theories, Concept of State, Nation and Nation-States, Concept of Boundaries, their classification and Frontiers, Sustainable Development and environmental sustainability with reference to India.

3. CLIMATOLOGY:-

Compositional and thermal structure of the atmosphere, Insolation: Solar source, heat balance of the earth, greenhouse effect and global warming, vertical and horizontal distribution of temperature, Atmospheric motion: Forces controlling motion of air, vertical motion and verticity, local winds, jet stream, general circulation in the atmosphere; Atmospheric moisture: humidity, evaporation, condensation, precipitation: formation, types, acid rain, world pattern of precipitation, Tropical, temperate and high latitude weather systems- concept

of air masses and atmospheric disturbances, ocean atmospheric interaction- El Nino, southern oscillation (ENSO) and La Nina, monsoon winds, northwesters and cyclones, Tropical and Temperate phenomena, climate of India and its controls: Eastern disturbances, Climatic classification of Koppen, and Thornthwaite, Major climates of the world- tropical, temperate, desert and mountain climate. Climatic Changes: Ozone Depletion; Global Warming: Strengthening of Greenhouse effect.

4. GEOGRAPHICAL THOUGHT:-

The field of geography and characteristics of geographical work, Classification of knowledge, place of geography among sciences, Nature of geographic knowledge during ancient (Greek, Roman and Indian) and Medieval (Arab) periods, Foundations of modern geography-contributions of Varenius, Kant, Humboldt and Ritter, Emergence of geography as a study of (i) physical features (ii) chorology (iii) landscapes. Concepts in geography: environmental determinism and possibilism, areal differentiation and spatial organization Dichotomy and dualism in Geography: Physical versus Human Geography and Systematic versus Regional Geography, Quantitative revolution-emergence of geography as spatial science Positivist explanations in geography-laws, theories, models Inductive and deductive logic in geographic explanations, Behavioural and humanistic perspectives in geography Social relevance in geography – Welfare, Radical and Feminist Perspectives Postmodernism and Geography.

5. REGIONAL PLANNING:-

Basic Concepts and Historical Development: Regional Planning: Concept, Nature and scope, Aims and objectives Rationale of Regional Planning, Principles of Regional Planning Historical Development: Regional Planning in the Developed World Regional Planning in Less Developed World, **Geography and Regional Planning:** Background and Philosophical Base. Role of Geography in Regional Planning. Methodology: Design Method, Regional Method .Techniques of Regional Planning: Analytical technique, Procedural techniques, **Regions for Planning:** Concept of Regions: Delineation and variables. Types of Regions, Planning Region: Concept and Characteristics Need and Importance of Planning Region. Principle, Criterion and Method for Planning Region.Planning Regions of India: Detailed Study of Planning Regions given by C.S. Chandrasekhara. Problems and Prospects of Regional Planning in India, **Surveys and Methods for Planning:** Concept and Functions of Surveys. Types of surveys: Regional and Diagnostic survey. Role of Geospatial Technology in planning Environment Impact Assessment.

6. QUANTITATIVE TECHNIQUES:-

Measures of Central tendency: Mean, median and mode. Measures of Central locations in spatial situation: types of spatial data and scales of measurement, concept of Mean centre, weighted mean centre and median point, Measures of dispersion: Mean deviation, standard deviation, coefficient of variation, measures of spatial dispersion along point, line and area distributions, Probability: Classical and relative frequency approaches to probability, calculation of probability: Law of addition, law of multiplication. Probability distributions: normal and binomial. Sampling: Basic concept, sampling frame, different sampling designs,

Measuring the strength of relationship: Scatter diagram, Spearman's rank correlation, Karl Pearson's product movement correlation coefficient, Regression analysis: Fitting a regression line by semi-averages and least square methods.

7. BIOGEOGRAPHY:-

Biogeography: Concept, field and significance and approaches to biogeographical studies Ecosystem: Concept, properties, components, types and functioning, Mountain Ecosystems: Mountain ecology, risks and vulnerabilities, Soil system: Definition, function, components and characteristics; Soil Profiles. Biomes: Meaning and major forest biomes of the world, Biodiversity: Meaning, types and importance of biodiversity, Extinctions of species and their global concern, Biodiversity and conservation, Biodiversity hot spots, The characteristics and evolution of living things: Lamarck and Darwin views of evolution, Factors affecting distribution of organisms, General characteristics of plants and animals. Plant association and succession, Taxonomic,Climatic, and Raunkiaer's classification of plants, Environmental Management: meaning, importance, Environmental governance and Management; Environmental policies and legislations: Conservation Act of 1972, Environmental Protection Act, 1986, Biological Diversity Act, 2002. Global Environmental problems and Sustainable Development.

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1. **ENVIRONMENTAL DISASTERS: MITIGATION AND MANAGEMENT:-**

INTRODUCTION TO DISASTERS: Disasters: Meaning and definitions, difference between disaster and hazard, causal factors, development leading to disaster, characteristics of disasters, forecasting and warning of disasters, elements of early warning systems, Classification of Disasters: Natural and man-made hazards, hazard zonation and risk assessment, mitigation strategies, Man- Made Disasters: Types and nature of man-made disasters, general effects and mitigation strategies for manmade disasters, Biological Disasters: Meaning, types, vulnerability, effects, preparedness and mitigation of Biological disasters, Chemical and Radiological Disasters: Causes, impacts and management of chemical and radiological disasters, **NATURAL DISASTERS- I:** Natural Disasters: Introduction, meaning, nature and types of natural disasters, general effects of natural disasters, Earthquake and Seismic Hazards: Origin and severity of earthquakes, effects of earthquakes, risk evaluation, seismic zonation of India with special reference to Himalayan Region, earthquake mitigation measures, Volcanic Eruptions: Nature, causes, monitoring and mitigation of volcanoes, Landslides: General characteristics, causes, vulnerability, effects, prediction and warning and risk reduction mitigation measures, Snow Avalanches: Formation of avalanches, classification, mitigation and management of avalanches, **NATURAL DISASTERS- II:** Floods: Causes of flood, flood and draught, erosion and sedimentation, flood prone areas of India and associated hazards, assessment and management of flood, Cyclones: Nature and genesis, anticyclones, weather associated with cyclones, Geological changes and other effects, Tsunami: Origin and nature, causes of tsunamis, wave propagation, impact on coastal areas, warning and prevention, tsunami mitigation measures, Drought: Meaning, types, general characteristics, causes and impacts, prediction and warning and mitigation measures, Heat and Cold Waves: Causes and impacts, prevention, preparedness and response, **DISASTER MANAGEMENT:** Disaster Management: Definition, objectives and scope of disaster management, elements of disaster management, role of professionals in the management of disasters, disaster management cycle, Disaster Response: Response plans, search, rescue and evacuation, community health and casualty management, **DISASTER MITIGATION AND PREPAREDNESS:** Disaster Preparedness: Disaster preparedness plans, pre-requisites of preparedness planning, role of Information Technology, education, communication, and awareness in preparedness, Rehabilitation and Reconstruction (R and R): Social and economic aspects of R and R, Housing, relocation, retrofitting, repairing and strengthening of houses, reinstating livelihoods, national policy on disaster management.

2. **CURRENT ENVIRONMENTAL ISSUES AND THEIR MANAGEMENT:-**

GLOBAL WARMING, GREENHOUSE EFFECT AND OZONE PROBLEMS: Global Warming Potential, Possible Impact of Global Warming, Greenhouse Effect – Policy Response, Kyoto Protocol, EI-NINO- Climate Cycle, Ozone in the Atmosphere, Ozone Depletion Process, Ozone Hole, Worldwide, Ozone Trends, the Montreal Protocol, Consequence of Ozone Depletion, **ACID RAIN, ATMOSPHERE TURBIDITY AND NUCLEAR:** Introduction, Nature and Development of Acid Rain, Acid Rain and Geology, Acid Rain and Aquatic Environment, Acid Rain and Terrestrial Environment, Acid Rain and Build Environment, Acid Rain and Human Health, Mitigation of Acid Rain Problems, Aerosol types, Production and Distribution, **OTHER ENVIRONMENTAL ISSUES:** Introduction, Consequences of global CO_2 changes; Strategies for Conservation of Environmental Changes Induced by CO_2 Rise, Problems of slums in urban cities, Cancer and AIDS, Descriptive and analytical markers and indicators of pollutants in the body; Water-borne, air borne, vector borne, genetic, contagious and non-contagious diseases and their management, Sanitation measures to control infectious diseases, Environmental problems in India (Narmada Dam, Tehri Dam, Almetti Dam, Soil erosion, Formation and reclamation of usar land, alkaline and saline soil; Unsustainable Agricultural Practices and Land Use Planning); recent problems like Delhi smog, crop burning, **ENVIRONMENTAL POLICES AND REGULATIONS:** Fundamental principles of environmental protection, Constitutional perspective: Fundamental right to wholesome environment, directive principles of state policy, National Environmental Policy, Environmental regulatory framework in India, Role of international Environmental Agencies-UNEP, GEF, UNFCC and IPCC, **ENVIRONMENTAL TREATIES AND CONVENTIONS:** Stockholm Convention (1972), Basel Convention (1989, 1992) Earth Submit at Johannesburg (2002) Earth Summit Rio De Janeiro (1992, 2012), Kyoto Protocol, 1997; Montreal Protocol, 1987; Ramsar Convention on Wetland, 1971, Paris Agreement (2015), Rotterdam Convention on Prior informed consent procedure for certain hazardous chemicals and pesticides in International schedule, Agenda 21, sustainable development goals, India's role in various conventions and contributions.

3. **ENVIRONMENTAL POLLUTION:-**

INTRODUCTION: Definition and sources of pollution, Different types of pollution, Global and regional scenario of pollution, **AIR POLLUTION:** Types and sources of air pollutants, Reaction of pollutants in atmosphere; atmospheric diffusion and stack performance, air quality standards, Introduction of basic instruments for sampling and analysis of air pollutants, Effects of air pollutants on flora and fauna, Biological indicators of air pollution, Bio-monitoring of air pollutions, **WATER POLLUTION:** Sources and kinds of water pollution, water quality standards, Effects of water pollutants on plants (phytoplankton and macrophytes); Effects of water pollutants animals (zooplankton, macro-benthic invertebrates and fish), Eutrophication and its impacts on organisms and communities, Impact of heavy metals, halogens, radio-nuclides on aquatic flora and fauna, **NOISE AND LAND POLLUTION:** Physiological, social and psychological effects of noise, Methods of noise abatement; shock waves and SST; Noise control in vehicles, Industrial noise control and effects, National and International standards, Soil pollution, Sources and management of municipal solid waste, Biomedical waste, Hazardous waste and Industrial waste, **THERMAL**

and RADIATION POLLUTION: Thermal pollution: Concept of thermal pollution, sources of thermal pollution, thermal power plant pollution, thermal effects on aquatic life, impacts on water quality, prevention of thermal pollution, Radiation pollution: Causes, effects (health hazards) and control measure of radiation pollution, Applications of ionizing isotopes in waste water and air pollution analysis and treatment.

4. **ECOTOXICOLOGY AND RADIATION IMPACTS:-**

CONCEPT and HISTORICAL BACKGROUND: Origin and scope of toxicology, relationship with other sciences, Development of environmental toxicology (Historical and evolutionary Perspective), Classification of toxicants, natural and synthetic toxins, sources of toxicants, Basic concepts of toxicology, types of toxicity, acute and chronic toxicity, Toxicants and toxicity, factors affecting toxicity, types of toxins and basic mechanism of action, **MODE OF ACTION AND EFFECTS OF TOXICANTS:** Environmental Toxicants: Mode of action of toxicants, factors affecting the metabolism of xenobiotics; transport process mechanism of toxicants, mode of action and impacts of Arsenic, Cadmium, Lead, Mercury, Carbon-Monoxide, Nitrous Oxide, Sulphur Dioxide, Ozone, Cyanide, mode of action of pesticides, Toxicity impacts: Health impacts of toxicants on human and aquatic life, long- term effects- chronic, carcinogenic, mutagenic and teratogenic effects, **OCCUPATIONAL HEALTH:** Health problems related to occupation (due to dust, heat, stresses, chemicals, toxic gases, insecticides and pesticides and metals) Risk Assessment and Management in the Workplace (Workplace Exposure Assessment, Risk Management in the Workplace), Dose response relationship, LD 50, LC 50, toxicity testing, acute toxicity tests, Sub-acute and chronic toxicity tests, heavy metal toxicity tests, **RADIATION IMPACTS:** Natural and man-made radiation, application of radiations, sources of ionizing radiation, types of ionizing radiation, radiation dose and units,

direct and indirect effects, Dose limits, radiation hazard, Personal protection and house-keeping and safety rules, **EFFECTS OF RADIATIONS:** Molecular and cellular radiobiology: Biological effects of radiation, Radiation lesions in DNA, Major types of DNA repair, DNA damage and repair, chromosomal aberrations and gene mutations, cell death, cell survival curve, consequences of unrepaired DNA damage, radiobiological definition of cell death, cell cycle effects, Impact of radiations on biological molecules (proteins, nucleic acids, lipid and carbohydrates), Radio-protectors and Industrial safety requirements, industrial radio-protector.

5. **ENVIRONMENT IMPACT ASSESSMENT:-**

OVERVIEW OF EIA, Objectives and developmental Concept, origin of EIA, Benefits of EIA, Indian directions guidelines (GOI different notification of EIA)**.** Rapid and comprehensive EIA perspectives, Sources and collection of data for EIA. Measurement of Impact (Physical, social, economic, natural), **EIA Methodology:** Outline of EIA process, Screening, Scoping, Purpose of scoping, impact implications, Baseline studies and superimposition of projected plant emission impacts; reliability of database; intrinsic and external database supports and interpretation; checklist, matrices, Overlays and Geographical Information System, Impact analysis and Predictions, Environmental Impact Statement [EIS];

Public hearing as part of EIA; EIA report, **PREDICTION and ASSESSMENT OF IMPACTS:** Prediction and Assessment of Impacts on Water Environment, Air Environment, Noise Environment, Biological Environment, Cultural and Socio-cultural Environment, EIA of River valley project, Hydro power project, Cement plants and Mining, Prediction and assessment of: Impact of tourism on environment, impact on flora and fauna in Himalayan region, **PUBLIC PARTICIPATION:** Social impact assessment (SIA), Strategic Environmental Assessment (SEA), types of impacts, Public involvement, Public Hearing compulsion, restoration and rehabilitation methodologies, Mitigation criteria, Project modification, Post project analysis, **ENVIRONMENTAL MANAGEMENT AND ISO CERTIFICATION:** Environmental Management Systems (EMS), ISO 14000 (EMS). Components of Environmental Management System-Objectives, Policies, Implementation and Review, Life Cycle Analysis –LCA. Waste minimization and product augmentation.

6. **REMOTE SENSING AND GIS:-**

INTRODUCTION TO REMOTE SENSING: Definition of remote sensing; introduction to concepts and systems, Scope of remote sensing, Electromagnetic Spectrum; Radiation principles; image characteristics, Remote sensing systems; remote sensing platform, Sources of remote sensing information; advantages of remote sensing, **MICROWAVE SENSING:** Types of microwave systems, advantages, band designation, range resolution, azimuth resolution, real and synthetic aperture systems, Radar equation, radar return and image, Signatures, dielectric properties and interaction with vegetation Surveying, Leveling, Triangulation, Geo-datic survey, **AERIAL PHOTOGRAPHS AND SATELLITE IMAGERIES:** Interaction between light and matter, Characteristics of aerial photographs, Visual interpretation of aerial photographs and satellite imageries, Instruments used in interpretation, Path and Row Index Maps; selecting and ordering images, **DIGITAL IMAGE PROCESSING:** Introduction to digital image processing, basic concept and principle, image rectification and restoration, Image enhancement; manipulation; image classification; the output stage; data merging; conclusion, **APPLICATION OF REMOTE SENSING IN ENVIRONMENTAL MANAGEMENT:** Remote sensing in natural resource management - forest resources, waterresources, land resources and mineral
resources, Hazard and disaster mapping and management, Introduction to GIS;
principle of GIS; terminology used in GIS; space and time inGIS, Maps and its
characteristics, map scale, map symbology; spatial relationship; data structure and spatial analysis in GIS; GIS data; software used in GIS.

7. **TECHNIQUES IN ENVIRONMENTAL MONITORING AND ANALYSIS:-**

SAMPLING METHODS: Sampling methodologies for Air, Water, Soil, Noise and Radioactivity in environmental matrices. Sampling protocols- Selection of sites, Time and frequency for sampling, Preservation, Storage and Handling of samples. Good Laboratory Practices, **ANALYTICAL INSTRUMENTS:** Principles, working and applications of High volume sampler, Respirable Sampler, Impactors, Cyclones, Particle Size Analyser, Gas Analysers, Spectrophotometer (UV-Visible), Flame Photometer, Atomic Absorption spectrophotometer (AAS). Head space analysis, leaching tests, and immunoassay, **ADVANCED MICROSCOPY AND CHROMATOGRAPHS:** Principles, working and

applications of Phase contrast, fluorescent, polarization Microscopes, SEM. Gas Chromatograph (GC), GC-MS, HPLC, Ion chromatograph, X-ray diffraction, ED-XRF, WD-XRF, ICP-MS, ICP-AES, **RADIATION DETECTORS AND MONITORS:** Principles and working of radiation detectors- gas filled, scintillation (inorganic and organic) and semiconductor. Principles and working of Alpha Counter, Beta Counter, Gamma-ray Spectrometer, Liquid scintillation Counter, Beta-Gamma survey meters, Alpha, Beta and Gamma contamination Monitors.

8. <u>ENVIRONMENTAL LAW, GOVERNANCE, ETHICS AND POLICY:-</u>

INTRODUCTION TO ENVIRONMENTAL LAWS: Historical background of Environmental Law and Policy in India, Constitutional mandate for environmental protection, Environmental Protection: Issues and Problems, Key International Efforts for Environmental protection, Sustainable Development: Essential features and Legal Implications, UN Framework Conventions on Climate Change, 1992, Kyoto Protocol, 1997, **ENVIRONMENTAL PROTECTION AND LAW:** Environmental laws, environmental Policy in India, Indian Constitution and Environmental Protection Environment (Protection) Act, 1986: Salient Features, Powers of Central Government under EPA, Prevention, Control and abatement of environmental pollution under EPA, Hazardous wastes (Management, Handling and Transportation) Rules, 2008, Public Liability Insurance Act, 1991, **POLLUTION ABATEMENT AND THE LAW:** Water (Prevention and Control of Pollution) Act, 1974: Salient Features, Powers and Functions of CPCB and SPCB under Water Act, Air (Prevention and Control of Pollution) Act, 1981, Powers and Functions of CPCB and SPCB under Air Act, Noise pollution (Regulation and Con trol) Rules, 2000 (Note: Only relevant provisions of the above Acts), **NATURAL RESOURCE CONSERVATION AND THE LAW:** Wildlife (Protection) Act, 1972: Salient Features, Protected Areas and Trade and Commerce under WPA, National Forest Policy, Forest Conservation Act, 1986, Biological Diversity Act, 2002, **JUDICIAL ACTIVISM AND ENVIRONMENTAL PROTECTION:** Judicial Response towards Environmental Protection, Public Nuisance under IPC (Sections 268,277,278,284, 290,291), Sections 133-143 of Criminal Procedure Code, 1973, Role of UN authorities in protection of Global Environment, Evolution of International Environmental Law, International Environmental Lawand the Challenge of Globalization, Recent Trends in International Law.

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1. **MICROPALAEONTOLOGY:-**

Amoeboid Protists and Calcareous Nannofossils: Foraminifera: Detailed morphology, classification of foraminifera including planktic and benthic Foraminifera. Benthic foraminifera as indicators of environmental change. Geological applications of foraminifera, ecology and geological history, Calcareous nannofossils: Outline of morphology. Application in biostratigraphy; Calcareous nannofossils and paleoclimate, Crustaceans, Pelagic Sea Snails and Algae: Ostracoda:Outline of morphology and classification, Ecology and environmental applications of Ostracoda including ancient and modern continental environments, Pteropods and Calcareous Algae: Brief Introduction of each group and their applications, Siliceous Microfossils Radiolaria: Outline of morphology, Classification and its applications, Diatoms and silico flagellates: Ecology, lifecycle, classification, applications and geological distribution of diatoms. Silico flagellate skeleton, classification, geological history and its applications, Palynology**:** Outline of morphology and classification of pollens and spores and charophyta, Environmental application of pollen and spores, Phosphatic and Organic Walled Microfossils, Brief Study of the phosphatic microfossils like Conodonts: Outline of morphology, classification, ecology, geological history, distribution and its applications, Study of organic walled microfossils Dianoflagellates like morphology, ecology and classification. Techniques in micropaleontology, principles and applications of SEM, EDX, and Cathodo luminescence.

2. **NEOTECTONICSANDEARTHQUAKES:-**

Plate Tectonics: Plate Tectonics: accreting plate boundary, subduction, transform faults, thrust and fold hotspots and mantle plumes; palaeo magnetism and motion of plates, driving mechanism, geodynamics and heat transfer. Dynamic evolution of continental and oceanic crust, **Orogenic Belts:** Tectonics of Precambrian orogenic belts of India. Formation of mountain roots, Anatomy of orogenic belts. Introduction to the Himalayan tectonics; longitudinal, transverse and out of sequence faults; Rate of deformation in the Himalaya – Quaternary, Holocene and GPS based rates; Tectonic deformation and seismicity in the Himalaya, Indo-Gangetic Plains & Peninsular India. Tectonic geomorphology of mountains (landscape response to isostatic and tectonic uplift, terraces, mountain front: escarpments, fault segmentation, mountain front sinuosity, scarp morphological changes with time), **Neotectonics:** Introduction to neotectonics and active tectonics; Mountain building process; Thrust and fold belts; Active faults: concepts, methods and case studies; Geomorphic markers of tectonic deformation; Active tectonics and alluvial rivers; Tectonics and erosion; Tectonic-climate interaction; Landscape response to active tectonics; GPS geodesy and its applications to lithospheric deformation, Rate of deformation and seismicity; Introduction to paleoseismology; Seismic hazard zonation at regional and local scale, **Faults and Earthquakes:** Anderson's theory of faulting. Mechanical paradox of over thrusts and

Hubbert-Rubey theory. Fault formation and development: Fault/shear zone rocks and their deformation mechanism. Strength and rheology of faults: the strong vs. weak fault debate; geology of earthquake source regions. Simple earthquake ruptures, earthquake scaling relations. Mechanics of complex and compound earthquakes: earthquake recurrence. Qualitative seismotectonic analysis. Seismo tectonics of trans
current faults, subduction zones; intraplate seismicity. A seismic vis-à-vis seismic faulting. Induced seismicity: reservoir and mining-induced, with suitable examples. Earthquake prediction: problems and strategies, Case studies.

3. **MINERAL RESOURCES AND MINERAL ECONOMICS:-**

Mineral Deposits in a Broader Geological Framework: Relationship between plate tectonics and metallogeny; Mineral deposits associated with convergent and divergent plate boundaries; Distribution of mineral deposits in space and time, **Ortho magmatic and Magmatic/Metamorphic-Hydrothermal Ore Deposits:** General characteristics and distribution of magmatic ore deposits: chromite deposits, Ti-V magnetite deposits, PGE sulfide deposits, Ni-Cu sulphide deposits, diamond deposits associated with kimberlites and lamproites; Classification of hydrothermal deposits; General characteristics and distribution of: porphyry Cu-Mo-Au deposits, Sn greisens, base metal skarn and carbonate-replacement deposits, volcanic-hosted massive sulfide deposits (VHMS/VAMS/VMS) and black smokers, Sedimentary-Hydrothermal and Sedimentary Ore Deposits: General characteristics and distribution of Mississippi Valley-type (MVT) Pb-Zn deposits, SEDEX Pb-Zn-Ag deposits, and Kuperschiefer or red-bed copper deposits. Ore deposits formed by chemical precipitation from surface waters and clastic sedimentation - Iron and manganese deposits and placer and paleoplacer deposits (Witwatersrand deposit). Ore deposits formed by supergene processes - supergene/secondary deposits, residual deposits-bauxite (Central Indian bauxite deposits), limonite and Ni laterites (New Caledonia), Mineral Economics: Classification of ore minerals, industrial minerals and building stones; Resources and reserves, concepts of strategic, critical and essential minerals; Concept of heritage stones and their relevance; Importance of minerals in national economy; National Mineral Policy; United Nations framework classification, law of the sea, and marine mineral resources.

4. **PETROLEUM GEOLOGY:-**

Composition, Origin and Accumulation of Hydrocarbon: Composition of hydrocarbon (petroleum and gas), kerogen and its type and geochemical signature; Mechanism of hydrocarbon generation; Migration, types and geological conditions; Migration pathway; Accumulation of hydrocarbons and types of traps (structural, stratigraphic and combination) and trapping mechanism; Isopach maps of traps, UNIT 2: Petroleum System and Reservoir: Petroleum system and hydrocarbon play concept, source rocks
and geochemical techniques of its evaluation; pyrolysis: techniques, hydrogen and oxygen indices; production indeices, vitrinite reflectance, thermal alteration and conodont alteration index and respective interpretations (maturation of hydrocarbons); Carrier beds and petro-physical properties of source rock, carrier beds, trap, and cap rocks; Reservoir morphology and characteristics of sandstones and carbonate reservoirs, reservoir management, petroleum system of Indian petroliferous basins, Sequence-Seismic Stratigraphy and Hydrocarbon Plays:

Concepts of sequence stratigraphy, sequence, para sequences, bed, system tracts, sequence boundaries, flooding surfaces, condensed sections, applications of sequence stratigraphy in hydrocarbon exploration; Facies maps; Sea level curves and role in hydrocarbon exploration; Basin analysis; Concept, terminology and applications of seismic stratigraphy in hydrocarbon exploration, **Exploration, Production and Environmental Impact:** Outline of production techniques in the petroleum industry; Principles related to evaluating potential reservoirs and the environmental and economical impact of the utilisation of the hydrocarbons.

5. **EXPLORATION GEOLOGY:-**

Earth's Gravity, Magnetic and Heat Flow: Concept of scale and unit in Geophysics; Signal and noise; Data acquisition and reduction; Concept of geophysical modelling; normal and reverse. Importance of geophysics in Industrial application; Gravity fields of the Earth: gravity potential, normal-gravity field; Shape of the Earth; Large scale gravity and isostasy; Isostatic rebound, Bouguer and isostatic anomalies, isostatic models for local and regional compensation, gravimeters: stable and unstable (Lacoste' and Ramberg gravimeter, Worden gravimeter), data acquisition and corrections; Regional and residual separation; Interpretation of anomalies for simple geometric bodies, e.g. single pole, horizontal cylinder, sheet, dyke and fault; Magnetism of the Earth; Geomagnetic field, inclination and declination; Latitudinal variation; Secular and transient variations in magnetism; Magnetic induction and residual magnetism; Magnetic potential and Poisson's equation, magnetometers; Rock/mineral magnetism (DRM, TRM), palaeomagnetism, reconstruction of paleopole position; Apparent Polar wandering curves and continental drift; Heat flow, error function and its application, **Seismic and Electromagnetic techniques:** Seismic wave and its propagation; Seismic impedance, seismic refraction (2 layer, 3 layer), seismic reflection, NMO, stacking; Seismology: elements of earthquake seismology; Focal mechanism and fault plane solutions; Plate boundaries and seismicity. Seismic gaps; Seismotectonics and structure of the Earth; Himalayan and stable continental region earthquakes, reservoir induced seismicity; Seismic hazards; Basic electrical quantities; Electromagnetic field techniques and interpretation; GPR utility mapping and applications, **Subsurface Geophysics-Well logging:** Basic formation evaluation concepts, borehole environment, principles of resistivity, radiation, thermal and elastic wave measurements and measuring tools; Lithology plots; Saturation, irreducible saturation and porosity studies from well logs; Shale sand analysis; Integration of core, log, well test and seismic data evaluation; Well logging and borehole geophysics in mineral exploration and groundwater exploration, **Drilling Techniques, Mineral Exploration and Reserves Estimation:** Drilling techniques; Geological aspects of site selection for drilling operations; Planning of drilling operations; Borehole surveys; Correction of deviated boreholes and directional drilling, core-sampling; Definition and terminology of mining geology; Classification of mining methods: open cast mining (quarrying), underground mining; Coal mining method: board-and-piller, longwall and room-and-piller methods; An introduction to prospecting and exploration of mineral deposits.

6. **ENVIRONMENTAL GEOLOGY:-**

Earth and Environment: Fundamentals; Earth in space and time; population growth and environment; natural hazards-causes and effects; risk assessment, **Hazardous Earth**

Processes: Earthquakes- earthquake origin and distribution, hazards, predictions, control; Volcanoes- magma and plate tectonics, environmental hazards, forecasting and risk assessment; Tsunami- causes, effect, risk and forecasting; Rivers and flooding- stream discharge, erosion and deposition, flood plains, flooding causes, effects and reducing flood hazards; Coastal environment- coastlines and sea level, major processes, hazards and mitigation; Landslides and mass movement- slope stability and types of mass wasting, consequences and preventive majors; Glacial and arid environment-types and movement of glaciers, ice ages, wind erosion, dunes and loess, desertification**, Earth Resources and Environment:** Water resources- hydrologic cycle, traditional freshwater sources and alternatives, groundwater withdrawal; Energy resources- petroleum, coal and natural gas, nonconventional and renewable energy resources; Mineral and rock resources- geology of mineral resources, mining and processing of minerals, environmental impacts and mitigation; Soil resources- formation, property and classification of soil, human activities and soil, **Environmental Management:** Waste management- municipality, toxic and radioactive wastes disposal, sewage treatment; Water pollution- point and non-point sources, industrial and agricultural wastes, pollution control-surface/groundwater; Air pollution and control; Environmental law and policy- resources law- water, minerals, fuels and geologic hazards, international resource disputes, pollutions and its control.

7. **ADVANCED GROUNDWATER HYDROLOGY:-**

Groundwater Exploration and Water Well Construction: Geologic and hydro geologic methods of exploration; Role of remote sensing in groundwater exploration; Surface geophysical methods — seismic, gravity, geo-electrical and magnetic methods; Types of water wells and methods of construction; Design, development, and maintenance of wells; Sub-surface geophysical methods; Yield characteristics of wells; Pumping tests- methods, data analysis and interpretation, **Groundwater Quality:** Physical and chemical properties of water; Quality criteria for different uses; Graphical presentation of groundwater quality data; Groundwater quality in different provinces in India; Groundwater contamination; natural (Geogenic) and anthropogenic contaminants; Saline water intrusion; Radio-isotopes in hydro geological studies, Organic and inorganic pollutants in water Isotope Applications in Groundwater Hydrology: Water balance: groundwater inflow and outflow estimates; Dating of groundwater; Percolation tank hydrology; Determination of groundwater velocity in saturated zone; Identification of recharge/discharge processes; Pollution migration studies; Isotope techniques for water resource management, Groundwater Development and Management: Assessment of Groundwater resources- dynamic and static resources; Concept of sustainable development of groundwater resources; Groundwater management —supply side and demand side management; Artificial recharge of groundwater- Concept of artificial recharge – recharge methods, relative merits, applications of remote sensing in artificial recharge of groundwater; Conjunctive use of surface and groundwater; Groundwater legislation.

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