# Vidyasagar University

## Midnapore-721102, West Bengal

**The SYLLABUS for**

**POST-GRADUATE Programme**

**in**

# GEOGRAPHY

Under Choice Based Credit System (CBCS)

(Semester Programme)


## [w.e.f. 2022-23]

## DIVISION OF MARKS

### Total marks: 1100 (Core) + 100 (Elective/CBCS)

| For Internal Students | | | | Elective/CBCS |
|---|---|---|---|---|
| **Semesters** | **Theoretical** | **Practical** | **Total** | **Total** |
| Semesters-I | 200 | 100 | 300 | - |
| Semesters-II | 150 | 100 | 250 | 50 |
| Semesters-III | 150 | 100 | 250 | 50 |
| Semesters-IV | 200 | 100 | 300 | - |
| **Total** | **700** | **400** | **1100** | **100** |

# STRUCTURE OF SYLLABUS

## SEMESTER-I
## (Duration: July – December)

| Type | Paper | Unit | Marks | | | | Credit | Total Class Hours |
|---|---|---|---|---|---|---|---|---|
| | | | End-term Exam. | Internal Exam | Unit Total | Paper Total | | |
| Theory | **GEO 101: Earth's Surface Processes** | GEO 101.1: Geotectonics | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 101.2: Geomorphology | 20 | 5 | 25 | | | |
| | **GEO 102: Hydrospheric Sciences** | GEO 102.1: Ocean Science | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 102.2: Hydrology | 20 | 5 | 25 | | | |
| | **GEO 103:Climate Science and Regional Geomorphology** | GEO 103.1: Climate Science | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 103.2: Regional Geomorphology of India | 20 | 5 | 25 | | | |
| | **GEO 104: Environmental Geography and Ecological Planning** | GEO 104.1:Foundations in Biogeography and Environment | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 104.2:Landscape Ecology & Planning | 20 | 5 | 25 | | | |
| Practical | **GEO 195:Hydrological Techniques and Geological & Topographical Maps** | GEO 195.1:Hydrological Techniques | 25 | - | 25 | 50 | 4 (0-0-8) | 60 hours |
| | | GEO 195.2: Geological and Topographical Maps | 25 | - | 25 | | | |
| | **GEO 196: Climate Change Techniques and Environmental Mapping** | GEO 196.1:Climate Change Assessment Techniques | 25 | - | 25 | 50 | 4 (0-0-8) | 60 hours |
| | | GEO 196.2:Ecological Census Techniques | 25 | - | 25 | | | |

## SEMESTER-II
## (Duration: January – June)

| Type | Paper | Unit | Marks | | | | Credit | Total Class Hours |
|---|---|---|---|---|---|---|---|---|
| | | | End-term Exam. | Internal Exam | Unit Total | Paper Total | | |
| Theory | **GEO 201:Geographical Thought and Population Geography** | GEO 201.1: Geographical Thought | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 201.2: Population Geography | 20 | 5 | 25 | | | |
| | **GEO 202: Social, Cultural & Rural Geography** | GEO 202.1: Social & Cultural Geography | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 202.2: Rural Geography | 20 | 5 | 25 | | | |
| | **GEO 203: Geopolitics and Environmental Ethics** | GEO 203.1: Global Economic Crisis and Geopolitics | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 203.2: Environmental Ethics | 20 | 5 | 25 | | | |
| | **ELECTIVE PAPER (THEORY)** | | | | | | | |
| | **C-GEO 204: Resource Management and Earth System Science** | C-GEO 204.1 : Resource and its Management | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | C-GEO 204.2 : Earth System Science | 20 | 5 | 25 | | | |
| Practical | **GEO 295: Thematic Mapping and Statistics** | GEO 295.1:Social Thematic Mapping | 25 | - | 25 | 50 | 4 (0-0-8) | 60 hours |
| | | GEO 295.2:Basic Statistics | 25 | - | 25 | | | |
| | **GEO296:Sedimentology and Remote Sensing and Aerial Photographs** | GEO 296.1: Sedimentology | 25 | - | 25 | 50 | 4 (0-0-8) | 60 hours |
| | | GEO 296.2:Remote Sensing and Aerial photographs | 25 | - | 25 | | | |

## SEMESTER- III
## (Duration: July – December)

| Type | Paper | Unit | Marks | | | | Credit | Total Class Hours |
|---|---|---|---|---|---|---|---|---|
| | | | End-term Exam. | Internal Exam | Unit Total | Paper Total | | |
| Theory | **GEO301:Environmental Engineering, Energy, Water, and Food nexus** | GEO 301.1: Environmental Engineering | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 301.2: Energy, Water, and Food nexus | 20 | 5 | 25 | | | |
| | **GEO 302: Regional Planning, Settlement & Transport Geography** | GEO 302.1: Regional approach in Geography and Planning | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 302.2: Settlement & Transport Geography | 20 | 5 | 25 | | | |
| | SPECIAL PAPERS (ANY ONE) –GEO-303 | | | | | | | |
| | **303A: Advanced Geomorphology** | GEO 303A.1: Process Geomorphology -1 | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 303A.2: Process Geomorphology -2 | 20 | 5 | 25 | | | |
| | **303B: Coastal Management** | GEO 303B.1: Coastal Processes | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 303B.2: Coastal Environments: Focus on Indian Regions | | | 25 | | | |
| | **303C: Urban Geography & Regional Planning** | GEO 303C.1: Foundation of Urban Geography | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 303C.2: Contemporary Urban Issues | 20 | 5 | 25 | | | |
| | **303D: Remote Sensing and Geographic Information System** | GEO 303D.1: Physical Basis of Remote Sensing | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 303D.2 Photogrammetry, Aerial Photo and Satellite System | 20 | 5 | 25 | | | |
| | **303E: Landscape Ecology with Metrics and Models** | GEO 303E.1 Theories in Landscape Ecology | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 303E.2 Metrics and Models in Landscape Ecology | 20 | 5 | 25 | | | |
| | **303F: Climate System with Statistical Climatology** | GEO 303F.1: Climate System | | | | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 303F.2: Statistical Climatology | | | | | | |
| | **ELECTIVE PAPER (THEORY)** | | | | | | | |
| | **C-GEO 304 : Environmental Issues and Management** | C-GEO 304.1 Emerging Issues and Policies on Environment | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | C -GEO 304.2: Environmental Hazards and Disaster Management | 20 | 5 | 25 | | | |
| Practical | **GEO 395: Field Work in Geography** | GEO 395.1:Field work and Community Outreach | 25 | - | 25 | 50 | 4 (0-0-8) | 60 hours |
| | | GEO 395.2:Field Report (As per special paper) | 25 | - | 25 | | | |
| | **GEO 396: Advanced Quantitative Methods and Digital Cartography** | GEO 396.1: Advanced Quantitative Methods | 25 | - | 25 | 50 | 4 (0-0-8) | 60 hours |
| | | GEO 396.2: GIS, Digital Cartography, and Geodesy | 25 | - | 25 | | | |

## SEMESTER-IV

## (Duration: January – June)

| Type | Paper | Unit | Marks | | | | Credit | Total Class Hours |
|---|---|---|---|---|---|---|---|---|
| | | | End-term Exam. | Internal Exam | Unit Total | Paper Total | | |
| Theory | **GEO 401: Dissertation Report and Viva-Voce (GEO 401.1-401.4)**<br>**GEO401.1:Problem Section and Methods of Study**<br>**GEO401.2: Field Investigation and Database generation**<br>**GEO401.3: Data analysis and Report Writing**<br>**GEO401.4: Viva-Voce** | MSc. Dissertation (Internship, exchange, collaborations (national & international), MoU, institutes, universities, Govt., NGOs, Private, Semi-govt. etc.) | 100 | - | 100 | 100 | 8 (0-0-12) | 120 hours |
| | **GEO 402: Tourism and Gender Geography** | GEO 402.1: Tourism Geography | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 402.2: Gender Geography and Environment | 20 | 5 | 25 | | | |
| | **SPECIAL PAPERS (ANY ONE) –GEO-403** | | | | | | | |
| | **403A: Advanced Geomorphology** | GEO 403A.1: Advanced Geomorphic Techniques | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 403A.2: Applied Geomorphology | 20 | 5 | 25 | | | |
| | **403B: Coastal Management** | GEO 403B.1: Coastal Ecology and Hazards | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 403B.2: Coastal Issues and Management | | | 25 | | | |
| | **403C: Urban & Regional Planning** | GEO 403C.1: Theoretical Bases of Regional Planning | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 403C.2: Planning for Urban Development | 20 | 5 | 25 | | | |
| | **403D: Remote Sensing and Geographic Information System** | GEO 403D.1: Advanced Remote Sensing | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 403D.2 Advanced GIS and Applications of Remote Sensing | 20 | 5 | 25 | | | |
| | **403E: Spatial Analysis in Landscape Ecological Dynamics** | GEO 403 E.1:Landscape Ecology and Dynamics | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 4043E.2: Spatial Analysis , Landscape Modeling and services | 20 | 5 | 25 | | | |
| | **403F: Applied Climatology** | GEO 403 F.1: Applied Climatology - 1 | 20 | 5 | 25 | 50 | 4 (3-1-0) | 60 hours |
| | | GEO 403 F.2: Applied Climatology - 2 | | | | | | |
| Practical | **GEO 495: Environmental Assessment and Spatial Analysis in Geography** | GEO 495.1: Environmental Monitoring and Assessment | 25 | - | 25 | 50 | 4 (0-0-8) | 60 hours |
| | | GEO 495.2:Spatial Analysis in Geography | 25 | - | 25 | | | |
| | **GEO 496: Research Ethics and Spatial Modeling in Geography** | GEO 496.1:Proposal Writing & Research Ethics | 25 | - | 25 | 50 | 4 (0-0-8) | 60 hours |
| | | GEO 496.2:Spatial Modeling | 25 | - | 25 | | | |

# SYLLABUS

## Semester- I (300 Marks)

### THEORETICAL COURSES (200 Marks)

### PAPER - GEO 101: EARTH'S SURFACE PROCESSES

**Full Marks: 50 Credit: 4**

#### GEO 101.1: GEOTECTONICS

**Course Outcome:** The focus of this course is to give an in-depth concept on the fundamental physical laws towards understanding the initial phases of the early universe with special reference to the Earth and the Moon. It also focuses on the basic understanding of the genesis of the Earth's magnetic field and palaeomagnetism that will enhance the understanding about the Earth's geological history and theories about the continental drift and sea floor spreading. The course is also designed to have some advanced level of understanding of the absolute dating techniques to find the ages of geological formation. It also includes the processes and mechanisms of mountain building. All these concepts and techniques will surely enhance the ability of the students for critical analysis and thereby synthesis of the Earth's system process. The completion of this course will give impetus to the research insights for the students who would like to pursue their future carrier in geosciences.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*
*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Origin and evolution of solar system with special reference to the Earth/Moon.

2. Relative and absolute dating: principles and techniques.

3. Origin of earth's magnetic field, paleomagnetism, geomagnetic polarity reversal and paleomagnetic timescale, paleomagnetic polar wandering curves and reconstruction of plate motions.

4. Mechanism of plate dynamics. Application of plate tectonic theory in explaining orogenesis, volcanism, earthquake.

5. Neo-tectonics and its worldwide evidences.

## GEO 101.2: GEOMORPHOLOGY

**Course Outcome:** This course aims to inform the learners about the principles and physical settings on which geomorphic processes work to develop characteristic landforms. Role of humans in shaping and reshaping the landscapes are given proper importance. Scope of application of geomorphic knowledge is explored. Students will learn about the mechanism and working principle of processes that lead to shape present earth-surface. Field demonstration on process-form relationship help in concretizing ideas. This understanding may help in formulating hydrological, geologic and economic planning. Learners may take part in hazard management too.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*
*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Key Concepts in geomorphology: historical and functional approaches, geomorphic threshold, ideas of feedback, equilibrium, and boundary conditions.

2. Weathering: Stresses, processes and landforms. Mass wasting and slope forms and processes.

3. Fluvial processes and forms: hydraulics and stream power, threshold energy for entrainment and transport, channel form and patterns, flood plains, alluvial fan, terraces and delta.

4. Anthropogeomorphology: Geomorphic impacts of land use conversion, mining, River engineering, alteration of coastal process-form, destabilizing slope.

5. Applied geomorphology in planning, hydrology and economic geology. Geomorphology in hazard Management (flood, landslide and subsidence) and EIA.

# PAPER - GEO 102: HYDROSPHERIC SCIENCES

**Full Marks: 50 Credits: 4**

## GEO 102.1: OCEAN SCIENCE

**Course Outcome:** The students will be able to understand the marine environment and oceanographic processes that leads to earth system processes. They can extend their ideas in understanding environmental and climatic processes too. An aptitude on the distribution of marine resources as well as their utilization and possible impact are also developed among the students.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*
*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. The Origin of Ocean Basins: Sea Floor Spreading; The opening and closing of ocean basins; Bathymetry of the Continental Shelf

2. Physical and Chemical Properties of Sea waters: Effects of Pressure, Temperature, and Dissolved salts on sea water density; Salinity; TS Diagram

3. Ocean Sediments: Types of shelf Sediments; Sediment Transport, Deposition and Accumulation

4. Ocean-Atmosphere Interactions: Land-ocean-atmosphere interactions; Ocean Climate Zones

5. Ocean Ecosystems: Coral Reefs; Rocky intertidal communities; Biology of coastal upwelling zones; Algal Blooms; Waste Disposal; National and International Law applied to the Oceans

## GEO 102.2: HYDROLOGY

**Course Outcome:** This course seeks to make the learners informed about the principles of hydrological systems operating at watershed level which leads to water availability and water budget. Learners will be appraised on how different hydrological parameters interact as an interacting whole. Magnitude frequency of hydrological extreme events and their trends under the context of global climate change are included. Students will learn about the working principle of earth system processes that lead to water availability and necessity for water management in the context of global climatic change. This understanding may help in water budgeting and formulating plan for water use and water management. Learners may take leading role in awareness generation among community for rain water harvesting and judicial water use.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*
*Pattern of setting questions: **Group- A** (Long Answer Type): Two questions, each of **8 marks** (without division), will be set for answering any one. **Group- B** (Semi-long Answer Type): Four questions, each of **4 marks** (without division), will be set for answering any two. **Group- C** (Short Answer Type): Four questions, each of **2 marks** (without division), will be set for answering any two.*

1. Hydrological systems, estimating water potential, and water budgeting at the watershed level. Hydrologic frequency analysis (Gumbel's equation and log probability law).

2. Precipitation estimates: point rainfall analysis, area-depth curve, Theissen network, and isohyetal method for estimating rainfall volumes. Time series analysis of precipitation; Mann-Kendall trend test, Sen's slope, change point analysis.

3. Infiltration and evapotranspiration: soil-vegetation complex and infiltration estimates. Methods of estimating evapotranspiration. Water use efficiency for the crops and measure of aridity.

4. Runoff estimates using curve number, and stream discharge estimates by the area-velocity method. Groundwater: storage structure, flow, recharge, and discharge.

5. Hydrographs and Rating curve: Time dimensions of hydrographs: the concept of unit hydrograph and rating curves and their significance. flood& drought as hydrological hazards.

## PAPER – GEO 103: CLIMATE SCIENCE AND REGIONAL GEOMORPHOLOGY

**Full Marks: 50 Credits: 4**

### GEO 103.1: CLIMATE SCIENCE

**Course Outcome:** This course is designed to build a fundamental understanding of climate and the science of climate change with some focus on atmospheric thermodynamic processes. It also addresses the influence of sea surface temperature on the Indian monsoon system.

Learning outcome: Upon completion, students can

a). Synthesise the meteorological phenomena at different space-time scale
b). analyze the rising levels of CO2 and global temperature rise and its effect on precipitation.
c). analyze the Indian summer monsoon rainfall variation due to IOD and ENSO event.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*
*Pattern of setting questions: **Group- A** (Long Answer Type): Two questions, each of **8 marks** (without division), will be set for answering any one. **Group- B** (Semi-long Answer Type): Four questions, each of **4 marks** (without division), will be set for answering any two. **Group- C** (Short Answer Type): Four questions, each of **2 marks** (without division), will be set for answering any two.*

1.The nature and scope of meteorology and climatology in Geographic study. Meteorological and climatological systems operate in different space-time scales: thunderstorms, tropical cyclones, jet streams, and planetary wind systems.

2.Understanding atmospheric pressure; gas laws, geopotential, hydrostatic equilibrium, partial pressure, relative humidity, and specific humidity. Pressure-volume relationship; adiabatic process. Atmospheric instability, the process of cloud development; the role of aerosols in cloud and precipitation process.

3.Basics of climate modeling, a one-dimensional climate model, role of greenhouse gas and aerosols in climate. The rising pattern of global CO2 and surface temperature. Climatology of temperature and precipitation, and their anomalies at a global and regional scale. concepts of short-range and long-range weather forecasting.

4.The mechanism of Indian summer monsoon: implication of elevated heat pump (EHP) theory in monsoon precipitation, MONEX; Sea surface temperature and its climate significance: Walker circulation and Indian ocean dipole, and their effect on Indian summer monsoon.

5.Climate change throughout geological periods – evidence and possible causes, consequences of global climate change as estimated by IPCC.

### GEO 103.2: REGIONAL GEOMORPHOLOGY OF INDIA

**Course Outcome:** Students will be able to learn about the regional boundaries of geomorphological regions in India and also understand the physiographic diversity of India and West Bengal, their unique characteristics and regional importance.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*
*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Geomorphology of Darjeeling Himalaya and Terai Region.

2. Tectonics, drainage and geomorphology of Western Ghats with special reference to Deccan Trap.

3. Geomorphology and soil-landform assemblages of Chhotanagpur Plateau and its adjacent areas of West Bengal.

4. Form, process and evolution of Ganga and Subarnarekha delta.

5. Tectonics and Geomorphology of the Andaman and Nicobar Islands

## PAPER – GEO 104: ENVIRONMENTAL GEOGRAPHY AND ECOLOGICAL PLANNING

**Full Marks: 50 Credit: 4**

### GEO 104.1: FOUNDATIONS IN BIOGEOGRAPHY AND ENVIRONMENT

**Course Outcome:** The living things interact with each other in various ways and with the non-living components that make up the environment in which we live. These non-living components include rocks, soils and water, as well as the atmosphere. All these interactions produce a complicated set of interrelationships and these interrelationships can take many forms. Thus, this paper on basics of environment and ecology prepares students for careers as leaders in understanding and addressing complex environmental issues from a problem-oriented, interdisciplinary perspective. Ecology is a scientific way of thinking about the world. This means that it involves a certain way of investigating, studying and writing about the systems. Student can learn the core concepts and methods from ecological and environmental perspectives and their application in environmental problem solving.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*
*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1.1 Content and Scope in Biogeography; Environmental factors: Atmosphere, Hydrosphere, Lithosphere and Biosphere and their relationships. Holistic Concept, Environment Complex, tolerances, amplitude, limiting and inhibiting effects

1.2 Biosphere as an ecosystem; Eco-physiological adaptations in plants and animals for stressed environments, anthropogenic impact on life support systems including flora, fauna, soil, terrestrial and aquatic ecosystems

1.3Population dynamics; factors leading to rarity, vulnerability and extinction of species, migration of species, patterns of survival, K and R selected species

1.4 Role of water, nutrient and energy in determining ecosystem process; concept of interspecific and intraspecific interaction, competition, niche and Keystone species, Flagship species

1.5 Biogeographic zones of India, Status of Biodiversity, Protected area Network, National Parks and Sanctuaries

**GEO 104.2: LANDSCAPE ECOLOGY AND PLANNING**

**Course Outcome:** Landscape ecology is the study of the pattern and interaction between ecosystems within a region of interest, and the way the interactions affect ecological processes, especially the unique effects of spatial heterogeneity on these interactions. This paper provides students with an introduction to the discipline of landscape ecology. Thus, this paper focuses on the characteristic scale of spatial pattern; defining the elements of pattern; connectedness, fractal geometry, how these aspects of pattern are interconnected in landscapes, and how they vary. It may help students detecting, analyzing, or simulating landscape change; and modeling populations or communities in landscape mosaics and educate students for professional life.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*
*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Landscape: Definition, concept, nature and role, ecological description of landscape.

2. Structure of Landscape: Patches (shape, size, nature and boundary), corridors (type, network, matrix) and mosaics, habitat arrangement measuring metrices (Shanon Diversity Index and Simpson Diversity Index).

3. Landscape Dynamics: Energy flow, species movement, nutrient movement.

4. Anthropogenic Modification: Impacts on Agricultural ecosystem and Forest ecosystem: Landscape assessment methods.

5. Landscape management and planning: Role of keystone species, conservation of fragmented habitats, sustainable landscape, and role of Traditional Ecological Knowledge (TEK) in conserving landscape. Role of GIS in landscape planning

# PRACTICAL COURSES (100 Marks)

## SEMESTER-I

## PAPER – GEO 195: HYDROLOGICAL TECHNIQUES AND GEOLOGICAL & TOPOGRAPHICAL MAPS

**Full Marks: 50 Credit: 4**

### GEO 195.1: HYDROLOGICAL TECHNIQUES

**Course Outcome:** Students will develop skills in application of theoretical knowledge of hydrology. They will learn on field as well as laboratory techniques for estimating different hydrological attributes as for example rainfall, run off, infiltration etc. in order to construct water budget. Students are enabled to analyse magnitude frequency of different hydrological hazards like fold and droughts and their social and economic applications. This knowledge will help them in formulating various hydrological projects and their successful management.

*Full Marks- 25*
*Pattern of Setting Questions: **Three** compulsory questions bearing marks **7, 7 and 6** respectively, will be set covering the whole unit. **5 marks** will be allotted for Laboratory Note Book and Viva-voce.*

1. Point rainfall analysis, area-depth curves, Thiessen network and Isohyetal methods to determine rainfall volumes. Time series analysis of precipitation; mann-kendall test, sen's slope and change point analysis.

2. Estimating infiltration using infiltrometre and other field techniques. Drawing infiltration curve.

3. Evaporation estimation: Use of evaporation pan and empirical equations using climatic data. Estimation of aridity index using climate data.

4. Runoff and discharge estimation: Curve Number methods for estimating runoff: area-velocity method for discharge estimate.

5. Construction of hydrograph, unit-hydrograph and rating curves.

### GEO 195.2: GEOLOGICAL AND TOPOGRAPHICAL MAPS

**Course Outcome:** The course aims to demonstrate how the rock beds under different structures are oriented in section as well as on plans of exposure. Learners will get practical knowledge on how landforms and drainage systems are developed on various geological structures. Topographical maps will offer fundamental understanding on spatial arrangement and spatial organization of relief (landforms), drainage, forest cover, settlements, population areas, transportation routes and social amenities. Students will achieve concrete idea of landform and drainage evolution in connection to different geological structures and also the workings of different earth-surface processes under fixed boundary conditions (lithology and structure). Knowledge on the topographical map help them to take part in courtry and urban planning

Full Marks- 25

Pattern of Setting Questions: **Three** compulsory questions bearing marks **7, 7 and 6** respectively, will be set covering the whole unit. **5** marks will be allotted for Laboratory Note Book and Viva-voce.

1. Identification of geological structures, series and unconformity

2.Drawing section of the given Geological Map (Unconformity, fold, fault, intrusion)

3. Identification of Rocks and Minerals with Megascopic and Microscopic study and Geomorphological Mapping techniques from the SOI Toposheet

4. Numbering schemes of topographical maps. Interpretation of physical and cultural landscapes: a) Relief, b) Drainage, c) Vegetation, d) Settlement and e) Transport

5. Basin Morphometry: Amplitude of relief, Average Slope, Ruggedness Index, Hypsometric analysis, Stream Order, Drainage Density, Braiding index, Sinuosity index, Radius of curvature.

## PAPER – GEO 196: CLIMATE CHANGE TECHNIQUES AND ENVIRONMENTAL MAPPING

**Full Marks: 50 Credit: 4**

### GEO 196.1: CLIMATE CHANGE ASSESSMENT TECHNIQUES

**Course Outcome:** This course will help students to visualize and answer the question, of whether climate change is real or not. This course will make capable students connect regional climate change with global climatic conditions. This course will support students to understand climate variabilities through data analysis, graphing, and plotting using Excel.

1. Global temperature: correlate CO2 data with global temperature to find out the relationship: Data sources, download, process and presentation.

2. Regional temperature: correlate CO2 data with global temperature to find out the relationship across India: Data sources, access, process and presentation.

3. Climatological anomalies: Temperature and precipitation anomalies in annual, seasonal and monthly scale.

4. Interpretation: Understanding the climate change based on the interpretation of derived data

5. Graphing and plotting: learn basic shortcuts, graphing and plotting in Excel with climate data, publication quality presentation.

## GEO 196.2: ECOLOGICAL CENSUS TECHNIQUES

**Course Outcome:** Students will develop cartographic skills for constructing various thematic maps and foster their abilities in showing the spatial distribution of various environmental elements and their proper interpretation. This ability will help them to formulate environmental plans and to manage and conserve vegetation, soil, water etc.

*Full Marks- 25*
*Pattern of Setting Questions: **Three** compulsory questions bearing marks **7, 7 and 6** respectively, will be set covering the whole unit. **5 marks** will be allotted for Laboratory Note Book and Viva-voce.*

1. Estimating Plant species types, number, frequency, species richness, dominance of species.

2. Ecological Sampling: Quadrate Method; nested quadrates, Distance sampling; line transacts, Gradesacts, DBH, Branching height, Canopy and Ground Coverage.

3. Analyzing micro level forest quality: DAFOR Index, Biodiversity Indices, Habitat Suitability Index, Habitat Capability and effective Index.

4. Estimation of Soil Texture, Colour, soil moisture, Soil PH, NPK, Organic Carbon, Nitrate and Ammonical Nitrogen.

5. Ecological Micro-zonation Mapping of fragmented forest area.

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# Semester- II (300 Marks)

## THEORETICAL COURSES (200 Marks)

### PAPER- GEO 201: GEOGRAPHICAL THOUGHT AND POPULATION GEOGRAPHY

**Full Marks: 50 Credit: 4**

### GEO 201.1: GEOGRAPHICAL THOUGHT

**Course Outcome:** This course aims to make the students understand the changing nature of geography as a distinct discourse and its development as a science of synthesis. Students will learn about the philosophical background that guides the approaches and ways of thinking to design teaching-learning and research under different discourses of Geography. It aims to achieve a clear insight into theoretical foundation of the subject that is articulated among different courses and guides to design objectives and methodological framework of geographical enquiry. This understanding helps the learners to locate themselves in the wide and dynamic philosophical domain of the discipline and help them to concentrate towards developing geography as a science of holistic synthesis.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*
*Pattern of setting questions: **Group- A** (Long Answer Type): Two questions, each of **8 marks** (without division), will be set for answering any one. **Group- B** (Semi-long Answer Type): Four questions, each of **4 marks** (without division), will be set for answering any two. **Group- C** (Short Answer Type): Four questions, each of **2 marks** (without division), will be set for answering any two.*

1. Geography as a science of synthesis. Changing nature of Geography: paradigm shift

2. Development in 20th Century: Pragmatism, Positivism and Quantitative revolution in geography

3. Development of critical social theories: Humanistic geography, Behaviouralism, Radicalism, Welfare geography, Feminist geography

4. Structuralism and Post-structuralism, Modernism and Postmodernism.

5. Spatial and Temporal dimensions: absolute, relative, material and social space, concept of 3rd space in geography, temporal geography, time-space prism. Applied Geography. Scope and opportunities under modern technology

### GEO 201.2: POPULATION GEOGRAPHY

**Course Outcome:** Through this module students will learn the various aspects of population growth process, its impact on economy, society and politics. Various policy regarding the control and development of human resources, their necessity, and outcome will be understood. This understanding will help them to take part in various govt. schemes and programmes relating to population issues.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*
*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Population growth: logistic and exponential growth, carrying capacity; Population composition and structure: Types, spatial and temporal variation and determinants of age, sex, literacy and rural-urban ratio.

2. Theories and approaches of population growth and regulation: Malthus, Marx and Neo-Malthusianism. Theories of migration (Ravenstein, Lee and Zelinsky)

3. Human development and gender issues: MDGs, SDGs, HDI, GDI, GEM-concept, measures and criticism.

4. Population projection: Concept, types and methods.

5. Population equilibrium, Contemporary Population related policies and issues; population ageing, child and maternal health

## PAPER- GEO 202: SOCIAL, CULTURAL & RURAL GEOGRAPHY

**Full Marks: 50 Credit: 4**

### GEO 202.1: SOCIAL & CULTURAL GEOGRAPHY

**Course Outcome:** The paper is based on the nature, scope and content of social and cultural Geography. The paper will examine the role of social divisions such as class, 'race'/ethnicity, gender and sexuality in shaping the social geographies of regions. Emphasis is given on cross- disciplinary, critical engagement with current events. On completion of the course, students are able to understand the nature, scope, and concept, relationship between culture and social environment, and right of information act, the cultural complex and traits of culture and its concepts, evolution to civilization and cultural system according to religion, language and geography, and global cultural changes.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*
*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Nature, scope and content of social Geography; Ethnicity, tribe, dialect, language, caste and religion.

2. Social structure and processes, social exclusion, geographies of social well-being with special reference to India.

3. Cultural Geography: Definition, scope and nature. Race, religion, language as cultural attributes with special reference to India, North-South, social -cultural divide.

4. World cultural Realms, Morphology of cultural landscape (Carl O Sauer) and cultural diversity. Cities as melting pot of culture. Traditional folk culture- crisis and transformation.

5. Cultural processes: Diffusion, acculturation, assimilation and cultural pluralism.

### GEO 202.2: RURAL GEOGRAPHY

**Course Outcome:** The focus of the course is to develop an idea about the approach to understanding the rural development. It includes the status report of the rural development in India on various accounts, i.e. agriculture, health, education, rural employment, infrastructure and rural electrification. The role of micro finance is also included to give students an understanding of the rural economic development. The students get an inclusive understanding of the rural development and its dynamics upon completion of this course.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*
*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Rural Geography, Rural development, Indicators of Development & Rural Development and their measurements.

2. Rural Economics: Agriculture Development and Land Reforms in India.

3. Rural Micro-finance, self-help group and women empowerment.

4. Rural Industries and entrepreneurship: Definition and meaning of rural industries. Relevance of rural industries in solving socio-economic problems with special reference to Food Processing and Tourism.

5. Rural Development Programmes: poverty alleviation schemes- National Rural Employment Guarantee Act, Jawahar Rozgar Yojana, Sampoorna Grameen RozgarYojana, Provisions of Urban Amenities in Rural Area (PURA); Infrastructural development programmes- Indira AvasYojana; Transport Development: Pradhan Mantri Gram Sadak Yojana

## PAPER- GEO 203: GEOPOLITICS AND ENVIRONMENTAL ETHICS

**Full Marks: 50 Credit: 4**

### GEO 203.1: GLOBAL ECONOMIC CRISIS AND GEOPOLITICS

**Course Outcome:** Students will develop their understanding on politics of space and spatial patterns of political and economic power distribution. This course will enable the of Government in India based on the principle of regional disparities in India. They will also know about the nature of conflict at national and global level centered on water and power resources. They will develop their interest in analyzing

factors and local as well as global implications of economic and political agglomerations in the form of economic and political blocs.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*
*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Transformed Geography: Concept of Liberalization, Privatization and Globalization (LPG),beginning of the globalization, globalization to glocalilisation.

2. Globalization and Economic Geography: Impact of globalization on agriculture, industry andtrade.

3. Globalization and cultural changes: Globalization and cultural transformations.

4. World economic order: Economic booms and crisis, future of globalization.

5. Globalisation and Geopolitics: Understanding relevance of Heartland and Rimland theory and the present-day geopolitics in the globalized world.

**GEO 203.2: ENVIRONMENTAL ETHICS**

**Course Outcome:** Environmental Ethics examines the ways we supposed to value the environment and the non-human inhabitants of the earth. It examines the moral relationship between human beings and non-human beings (including the environment itself). This paper will consider the implications of this examination for an ethical life. It demonstrates the ethical conduct in all scientific activities. The paper includes both philosophical bases( moral obligations, the nature of value) and policy measures to be adopted for the betterment of the environment and earth. The students will be able to explain and apply principles of environmental ethics and apply philosophical concepts used in environmental ethical decision-making. They may apply theories and concepts to particular cases, and ability to provide critical assessment of arguments.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*
*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Environmental ethics and education; Concept, development of environmental philosophy, Ecocentrism and Anthropocentrism, the land ethic (Aldo Leopold), Gaia concept, Ecofeminism. Formal and non-formal environmental education, Tbilisi conference, environmental awareness.

2. Approaches to conservation of environment: Landscape ecology and ethno-ecology, environmental stewardship.

3. Environmental Impact Assessment (EIA), Environmental Management Planning (EMP), Environmental Performance Assessment (EPA), Environmental Audit

4. Global Environmental Issues and Conferences, Achievements and Failures: Thrust areas, Citizen movement, Inter- Governmental Panel for Climate Change (IPCC).

5. Environmental Laws in India: Wild life Act, Forest Acts, Environmental Protection Act, National Environmental Tribunal Act.

## ELECTIVE PAPERS (CBCS)

## PAPER- C-GEO 204: RESOURCE MANAGEMENT AND EARTH SYSTEM SCIENCE

**Full Marks: 50 Credit: 4**

### C-GEO 204.1: RESOURCE AND ITS MANAGEMENT

**Course Outcome:** The course is designed for basic understanding for the students from different discipline other than Geography. It includes the fundamental concepts of natural and human resources and their management and planning strategies. On completion of this course, the students get a founding knowledge of the natural resources in environment.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*
*Pattern of setting questions: **Group- A** (Long Answer Type): Two questions, each of **8 marks** (without division), will be set for answering any one. **Group- B** (Semi-long Answer Type): Four questions, each of **4 marks** (without division), will be set for answering any two. **Group- C** (Short Answer Type): Four questions, each of **2 marks** (without division), will be set for answering any two.*

1. Geography as a science of synthesis; social relevance of geography
2. Resource assessments, management and mapping
3. Human resource development in backward region.
4. Indicators of livelihood security.
5. Microlevel resource planning in watershed scale.

### C-GEO 204.2: EARTH SYSTEM SCIENCE

**Course Outcome:** The course is designed with an interdisciplinary approach for the students from outside Geography. It includes the fundamental ideas of Geotectonics, atmospheric composition and processes, the surface geomorphology and sea bathymetry. On completion of this course, these fundamental concepts will help the students from other branches to have a basic idea of geosciences.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*
*Pattern of setting questions: **Group- A** (Long Answer Type): Two questions, each of **8 marks** (without division), will be set for answering any one. **Group- B** (Semi-long Answer Type): Four questions, each of **4 marks** (without division), will be set for answering any two. **Group- C** (Short Answer Type): Four questions, each of **2 marks** (without division), will be set for answering any two.*

1. Earth surface processes and Geo-tectonics.
2. Composition of atmosphere and atmospheric processes.

3. Bottom relief of major oceans; temperature and salinity distribution.
4. Principles of mapping and applications.
5. Regional geomorphology of West Bengal.

# PRACTICAL COURSES (100 Marks)

## SEMESTER-II

### PAPER – GEO 295: THEMATIC MAPPING AND STATISTICS

**Full Marks: 50 Credit: 4**

### GEO 295.1: SOCIAL THEMATIC MAPPING

**Course Outcome:** Students will develop cartographic skills for constructing various thematic maps and foster their abilities in showing the spatial distribution of various physical as well as social elements and their proper interpretation. Skill of understanding spatial integration among physical and social elements will be developed to foster the abilities of holistic abilities.

*Full Marks- 25*
*Pattern of Setting Questions: Three compulsory questions bearing marks 7, 7 and 6 respectively, will be set covering the whole unit. 5 marks will be allotted for Laboratory Note Book and Viva-voce.*

1. Mapping of farming practices: Crop-combination, diversification and cropping intensity.

2. Mapping of social vulnerability and social disparities, ethnic mapping.

3. Estimation and Mapping of Social Well-being, HDI, GDI, GEM.

4. Estimation of Human Poverty Index –(HPI-I and II) for developed and developing countries

### GEO 295.2: BASIC STATISTICS

**Course Outcome:** The course, split into two units, corresponds to the basic and advance statistics, is a starting point of escalating the statistical analytical skills. It includes the founding concepts of probability distribution including the advanced linear modelling with matrix solution to the multivariate linear and non-linear model. These concepts are essential for augmenting the analytical skills of any beginner in Geography that includes both physical and social aspects of academic discipline. Upon completion of this course, the students get the benefit of having a strong mathematical and statistical analytical skills.

*Full Marks- 25*
*Pattern of Setting Questions: Three compulsory questions bearing marks 7, 7 and 6 respectively, will be set covering the whole unit. 5 marks will be allotted for Laboratory Note Book and Viva-voce.*

1. Measurement in Geography: Nominal, ordinal, interval and ratio measurement.

2. Concept of covariance, correlation and regression: Bi-variate analysis - linear, exponential, Product moment correlation, Spearman's Rank correlation, correlation matrix, partial correlation, residuals - mapping of residuals.

3. Probability distribution: addition and Law of multiplication, concept of probability distributions (binomial distributions, normal probability distribution), properties of normal curve.

4. Hypothesis testing: Formulation, Rejection rule, one and two tailed tests, significance level, degrees of freedom type I and type II errors, Standard Error. Different types of significance test for various purposes. Chi- square test, student's t- test.

5. Sampling techniques for geographical analysis.

## PAPER-GEO-296 SEDIMENTOLOGY AND REMOTE SENSING & AERIAL PHOTOGRAPHS

**Full Marks: 50 Credit: 4**

### GEO 296.1: SEDIMENTOLOGY

**Course Outcome:** This course seeks to make the learners capable in dealing practical hydrological problems like calculating rain input over an area especially a basin, rate if infiltration and that of evapotranspiration in a way to prepare hydrological budget. They will learn how to construct hydrograph, unit-hydrograph and rating curves. Students will develop aptitude and abilities on different methods of sediment sampling from field. They will also be trained thoroughly on laboratory method and field method of sediment analysis. This will help them to understand various types of environment and process domain under which sediments were deposited. Thus they can develop skills for reconstructing past.

*Full Marks- 25*
*Pattern of Setting Questions: **Three** compulsory questions bearing marks **7, 7 and 6** respectively, will be set covering the whole unit. **5 marks** will be allotted for Laboratory Note Book and Viva-voce.*

1. Texture analysis of sediment samples using standard techniques: Cumulative Frequency, Standard Deviation, Sorting, Skewnessn and Kurtosis

2. Form and shape analysis of pebble grade sediments.

3. Megascopic and microscopic examination of sediments.

4. Identification of sedimentary and bioturbation structures.

5. Sedimentary environmental facies analysis.

## GEO 296.2: REMOTE SENSING AND AERIAL PHOTOGRAPHS

**Course Outcome:** The course content is focused on basic understanding of satellite remote sensing and aerial photography. Basic principles of satellite motion and sensor parameters including the principles of air photo help the students to formalize with the modern space based analytical techniques. Upon completion of this course, the students will get benefit from rigorous practice and comprehensive theories.

*Full Marks- 25*
*Pattern of Setting Questions: Three compulsory questions bearing marks 7, 7 and 6 respectively, will be set covering the whole unit. 5 marks will be allotted for Laboratory Note Book and Viva-voce.*

1. Physics of Remote Sensing: Electro Magnetic Radiation (EMR), Radiation laws (wavelength frequency-energy relationship of EMR numerical problems).

2. Satellite System: Keplers's Laws, Major-Semi-major axis, eccentricity, velocity (Numerical problems).

3. Satellite Sensors: Concept of IFOV, resolution and determination of pixel size, referencing scheme of satellite system (path/row calculation).

4. Basics of Aerial Photograph: Basics geometry of aerial photograph, determination of scale and height, Distortions, Image parallax, Relief displacement.

5. Stereoscopy and Aerial Photo Interpretation: Stereoscopy, Pseudoscopy, Mirror Stereoscope, mosaic, edge information, mapping of Physical and Cultural features with the Air photo interpretation keys: shape, size, pattern, tone, texture, shadow, site and associations, Concept of DRONE image processing

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# Semester- III (300 Marks)

## THEORETICAL COURSES (200 Marks)

## PAPER - GEO-301: ENVIRONMENTAL ENGINEERING, ENERGY, WATER, AND FOOD NEXUS

**Full Marks: 50 Credit:4**

### GEO 301.1: ENVIRONMENTAL ENGINEERING

**Course Outcome:** This course will introduce the students to the domain and scope of environmental engineering. They will be trained on the mechanism of waste water treatment and solid waste management. They will learn the sources and impact of air and noise pollution along with management strategies. Learners will be skilled on the arsenic and fluoride pollution and mitigation strategies. This course aims to capacitate learners to participate in making of pollution free environment and environmental restoration drive. Students will learn about the necessity and mechanism of waste water treatment and understand the procedures to manage air and noise pollution and arsenic pollution. This fundamental understanding and knowledge help them to get engaged in various non-government and government initiatives working for the better environment.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Definition and domain of Environmental Engineering, Waste water treatment: Primary, Secondary and Tertiary treatment.

2.Solid (Municipal) waste management: Plastic Pollution; Sludge treatment; Hazardous waste management.

3. Air pollution: sampling and measurement, air pollution control technologies. Indoor pollution. Noise Pollution: Measurement of noise, Biophysical impacts, Mitigation technologies.

4. Arsenic and Fluoride Pollution: Spatial distribution, Impact and Mitigation.

5. Environment Restoration: Principles, Planning and Techniques

### GEO 301.2: ENERGY, WATER, AND FOOD NEXUS

**Course Outcome:** The course outcome will help the students to understand the nexus approach to complex and dynamic interrelationships between water, energy, and food, so that we can use and manage our limited resources sustainably. It forces us to consider the consequences of a decision in one sector not only on that sector but also on others.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Concept: Understanding water-energy-food nexus (WEF) Policies

2. Water infrastructures, conflict and cooperation: Building dams and barrages for energy and irrigation: Opportunities and challenges; WEF nexus behind conflict and cooperation in transboundary river basins

3. Energy production and consumption: Renewable and non-renewable energy resources: Emerging challenges and opportunities

4. Food production: Green revolution and farm mechanisation in the light of WEF nexus

5. Food security: Ensuring food security through managing WEF nexus

## PAPER - GEO 302: REGIONAL PLANNING, SETTLEMENT & TRANSPORT GEOGRAPHY

**Full Marks: 50 Credit: 4**

### GEO 302.1: REGIONAL APPROACH IN GEOGRAPHYAND PLANNING

**Course Outcome:** The learners will be able to know the process of planning in India, its role and various strategy for the development of our country. The students will understand how they can participate in the planning and development of the nation. This knowledge is very effective for the government also for smooth conduction of the development planning.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Concept and types of planning; planning regions in India: Purpose, types and methods of delineating planning region.

2. Basic principles and methodology of regional planning

3. Regional planning strategies: Centralized, decentralized and multilevel planning for rural and urban areas, people's participation in planning- Panchayati Raj Institution.

4. Regional disparities: Concept, Types; Demographic, social and economic disparities in India.

5. Planning of problem regions: Tribal, coastal, drought prone area, flood prone area.

## GEO 302.2: SETTLEMENT & TRANSPORT GEOGRAPHY

**Course Outcome:** Learners will be trained on the role of transport in overcoming the friction of distance. They will know how the transport cost is fixed, and comparative cost advantage of different modes. They will learn the advantage and role of public transport in addressing transport related global issues. They will concentrate on the role of communication technology in reducing the demand for transport. Students will learn about the role of transport in entire economic and social processes. This course aims to make students understand the locational advantage of different economic and social institutes based on transport principle. They are made aware of the role of public transport in addressing the problems of congestion and air pollution. This understanding may help them in formulating plan for regional development and economic regeneration by proper transport planning.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Concept of shelter; Dwelling places as cultural expression, Census categories of settlements; Types, building materials and architectural design of houses- dependence on climate.

2. Site, situation and spacing of settlements- dependence on terrain characteristics and water availability, Concepts and components of rural and urban morphology, Socio-economic segregation of rural settlements, Cities as melting pot of culture.

3.Concept of distance, space-time relation through transportation. Principles of transport cost fixation, comparative cost advantage

4.Planning for public transport, desired characteristics, modes and optimal pricing, services, ownership and regulation.

5. Transport Policy: Problem oriented and objective-led approach; Communication Technology- roles in reducing transport demand.

# PAPER – GEO 303: SPECIAL PAPERS

**Full Marks: 50 Credit: 4**

## 303A: ADVANCED GEOMORPHOLOGY

### GEO 303A.1: PROCESS GEOMORPHOLOGY-1

**Course Outcome:** Students will learn about the mechanism and working principle of geomorphic processes in details that lead to shape present earth-surface. This understanding may help in formulating engineering plan for management of land, water and soil, three basic resources on earth surface. They will also have a clear insight into the process and forms on the surface of Moon and Mars.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Geomorphic Thresholds: Reynold Number, Froude Number, Critical shear Stress and Shield Diagram, Slope stability thresholds.

2. Weathering Process and Soils with special reference to laterisation; Development of badland topography.

3. Slope forms and Processes: Mass Movement, Slope Morphology and Evolution.

4. Fluvial Processes: Drainage network development; Channel Morphology in alluvial and bedrock channels, Open channel flow, Sediment Transport, Fluvial response to changing conditions with special reference to channel patterns. Development of fluvial landforms.

5. Planetary geomorphic processes and landforms: Moon and Mars.

### GEO 303A.2: PROCESS GEOMORPHOLOGY-2

**Course Outcome:** Students will learn about the mechanism and working principle of geomorphic processes in details that are operating since historical time to shape present earth-surface. This course aims to build an understanding role of humans in shaping earth surface and regulating natural processes and their outcome on natural systems. Learners may take part in sustainable resource management.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Long term landform evolution with special reference to planation development

2. Quaternary Environmental Change and Landform Development with special reference to glaciations and sea level change.

3. Glacial and Periglacial processes and landforms.

4. Anthropogeomorphology: Man as active geomorphic agent. Landuse change and its geomorphic implications.

5. Identification of Geomorphosites with special reference to India.

## 303B: COASTAL MANAGEMENT

### GEO 303B.1: COASTAL PROCESSES

**Course Outcome:** The learners will understand the systematic interactions among terrestrial atmospheric and marine processes along the coast as a systematic whole. They will learn the dynamic and functional interrelationship between forms and processes in a coastal region and their dynamic equilibrium.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Definition of coastal zone, relevance of coastal study, classification of coast - Beach stage model.

2. Wave hydrodynamics; wave modification near coast with special reference to attenuation, breaker types, energy dissipation during breaking wave.

3. Tide; diurnal and semi-diurnal, rotating and progressive tide, concept of live storage, tidal environment with special reference to estuary.

4. Coastal current; intensity of long shore component and its implications, cell circulation.

5. Macro land forms with special reference to beaches and dunes; micro and biogenic forms.

### GEO 303B.2: COASTAL ENVIRONMENTS: FOCUS ON INDIAN REGIONS

**Course Outcome:** Students will get knowledge about long term and short-term development of landforms by several processes in some of the coastal regions in India and form process relationships in different spatial and temporal scales. They will understand the problems of coastal erosion and other hazards in the context of global climatic change.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without*

*division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1.Tide dominated coastal environment: (Estuaries of India, estuary morphology, estuary hydrolodynamics); wave dominated coastal environments: (The shore face, beaches, barriers and human activity)- Indian experiences.

2. Morphodynamic behavior of coastal systems (Modification of coastal features in temporal and spatial scales with feedback mechanisms).

3. Carbonate platforms and beach rocks (Andaman and Nicobar Islands).

4. Coastal erosion problems (West Bengal, Orissa coasts), land reclamations and associated problems (Sundarban coastal tract).

5. Techniques for assessing coastal hazards areas (Hazard zonation along the coasts).

## 303C: URBAN GEOGRAPHY AND REGIONAL PLANNING

## GEO 303C.1: FOUNDATION OF URBAN GEOGRAPHY

**Course Outcome:** This paper will provide knowledge on spatial analysis of functions of urban areas. Social and economic characteristics of cities and suburbs will be discussed under this paper. Urban land use and its impact on environment and ecology will be addressed. This paper will introduce students to the basics of urban geography, such as definition of cities, central place theory, National urban systems, and traditional models of urban spatial structure. More importantly, students will be exposed to contemporary urban topics such as global cities, urban sprawling, urban green space, urban ecology and footprints etc. Emphasis will be placed on the urban experience of developing countries, especially India. The students will be able to assemble knowledge of urbanism and urbanization as historic, geographic, social, and cultural processes, historical development, contemporary condition, and environmental impact of cities and urban related issues growing from exposure to the disciplines of Geography and Planning

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Development of urban geography: Definition of Towns, cities and metropolitan area. Trends of Urbanisation in the World and India.

2. Concept and definitions of urban system: Urban, urbanization, urbanism and urban ecology, National urban system, National urbanisation policy.

3. Today's cities and suburbs: suburban sprawl, smart growth, exurbs, the new cities and gated communities, gentrification, green city, Urban Livability Index.

4. Origin and growth of urban living: bases and processes, Historical perspectives on world urbanization

5. Urban planning, policies and regeneration: Architectural vision, European, Anglo American tradition and planning the social city, the new towns movement, toward planning for sustainable urban development.

## GEO 303C.2: CONTEMPORARY URBAN ISSUES

**Course Outcome:** Student will understand through this module various socio-economic and environmental problems with the growing urbanization in our country as well as various parts of the world. This knowledge will help them to surmise the necessity of urban planning and they will be able to evaluate the effectiveness of various govt. programmes for urban planning

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Changing spatial and temporal scenario of metropolitan development in India.

2. The economy of urban areas: structure of urban economy-basic and non-basic activities.

3. Social environment of the city: Social stratification, social class diversity, suburban social class, poverty, strangers, crowding, crime and homelessness.

4. Urban environment problems: Heat island, drainage, sewerage, sanitation, solid waste, transport, pollution and health, the city's ecological footprint.

5. Urban renewal and Urban redevelopment in India: Role of JNNURM, Smart city, AMRUT and Housing for All by 2022.

# 303D: REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

## GEO 303D.1: PHYSICAL BASIS OF REMOTE SENSING

**Course Outcome:** The course is designed to give fundamental and some advanced knowledge of space based remote sensing and aerial photography. From orbital parameters of satellite to complexity of aerial camera and film in association with the flight parameters, all of these will allow students to get an in-depth understanding of remote sensing and aerial photographic system.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Physics of Remote Sensing: Source of Energy, Electro Magnetic Radiation (EMR), Radiation laws (wavelength-frequency-energy relationship of EMR), influence of atmosphereon Remote Sensing operation.

2. Fundamental of Thermal Remote Sensing: Radiant temperature, Kinetic temperature, Black body and real body radiation.

3. Satellite orbits and Trajectories: Principles of satellite movements, orbits and trajectory, orbiting satellites-basic principles, orbital parameters, types of satellites.

4. Satellite Platforms and Sensors: Types of platforms for civilian applications, advantages, disadvantages, and characteristics of various satellite platforms. Physical principles and characteristics of various satellites sensor, sensor selection parameters, and resolution, Remote Sensing Data: Data acquisition and reception, Data products, storage, and dissemination.

5. Active and passive remote sensing systems, multispectral remote sensing; DN to radiance and reflectance conversion, Principles atmospheric correction for estimating surface reflectance from the satellite images. Retrieval of land surface temperature from satellite images. The implication of land surface temperature in geospatial contexts.

## GEO 303D.2: PHOTOGRAMMETRY, AERIAL PHOTO AND SATELLITE SYSTEM

**Course Outcome:** The course is designed to give fundamental and some advanced knowledge of space based remote sensing and aerial photography. From orbital parameters of satellite to complexity of aerial camera and film in association with the flight parameters, all of these will allow students to get an in-depth understanding of remote sensing and aerial photographic system.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Basics of Aerial Photograph: Types of aerial photographs, Geometry of single Aerial Photograph, Photographic overlap, flight planning, Scale, Lens Distortions, Relief distortions and Tilt distortions. Image displacement and parallax.

2. Aerial Photographic Film: Film density and Characteristics Curve, Colour Infrared Films, Film resolution, Filters.

3. Photogrammetry: Development of Photogrammetry, Classification, processes and Limitations of photogrammetry.

4. Stereo photogrammetry: Conditions for Stereo vision, stereoscopic measurements, Sterescopic 3D viewing, Image parallax, Rectification, Orthorectification; Concept of Drone

5. Satellite Systems: Whiskbroom system, Pushbroom system, Microwave system, coarse resolution, fine resolution and very fine resolution system.

## 303E: LANDSCAPE ECOLOGY WITH METRICS AND MODELS

### GEO 303E.1: THEORIES IN LANDSCAPE ECOLOGY

**Course Outcome:** Landscape ecology is the study of the pattern and interaction between ecosystems within a region of interest, and the way the interactions affect ecological processes, especially the unique effects of spatial heterogeneity on these interactions. This paper provides students with an introduction to the discipline of landscape ecology. Thus, this paper focuses on the characteristic scale of spatial pattern; defining the elements of pattern; connectedness, fractal geometry, how these aspects of pattern are interconnected in landscapes, and how they vary. It may help students detecting, analyzing, or simulating landscape change; and modeling populations or communities in landscape mosaics and educate students for professional life.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Introduction to landscape ecology: Definition of Landscape; Concept of Landscape Ecology

2.Theory in landscape ecology: Hierarchy theory and the landscape, Equilibrium versus non-equilibrium landscapes, Scale- temporal and spatial

3. Landscape pattern: context and process, gradient concept of landscape structure, Applications of landscape ecology in Farmland, forest land and wildlife

4. Loss, degradation, fragmentation and isolation of habitats- nature, causes and impacts on individual species; Changes in behavior, species movement, maintenance of Keystone and endangered species

5. Landscape conservation: a new paradigm for the conservation of biodiversity

### GEO 303E.2: METRICS AND MODELS IN LANDSCAPE ECOLOGY

**Course Outcome:** This course is designed for students to obtain knowledge of basic concepts, methods, and applications in landscape ecology, to examine and understand the ways in which spatial patterns and spatial processes operate in an ecological context, to learn and become familiar with the techniques used by landscape ecologists in their work, to understand the relevance of landscape ecology to human society, and to apply the concepts, models, and techniques in landscape ecology in natural resources management.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two*

1. Landscape Elements: Patch, Boundary, Edge mosaic, corridor, Ecotone, Ecotope and Fragmentation

2. Landscape composition and configuration, Heterogeneity

3. Landscape Metrics at Patch, Class and Landscape level; Area and Edge Metrics, Shape Metrics, Core Area Metrics, Contrast Metrics, Aggregation Metrics, Diversity Metrics.

4. Landscape Ecology and Models; Neutral Models in Landscape Ecology

5. Metrics and models for quantifying landscape structure and estimation of landscape ecological quality

## 303F: CLIMATE SYSTEM WITH STATISTICAL CLIMATOLOGY

### GEO 303F.1: CLIMATE SYSTEM

**Course Outcome:** This curse is designed to produce a deeper understanding of fundamentals of climate system. The course is distributed in three specific manners; the first unit contains basic principles of climate system and climate modelling, including some focus on the physics of cloud and aerosols in the atmosphere. The second unit deals with statistical methods to analyse the climate parameter toward understanding their dynamics at the global and regional scales. The third and fourth units deal with air sampling and data analysis using satellite data.

Learning outcomes: Upon the completion of this course,

1. Students can answer to the question of changing global surface temperature
2. Have the capacity to analyze the cloud-earth-energy-radiation system
3. Can analyze the changing relation of precipitation and atmospheric aerosols
4.Can analyze the long distance teleconnection of ENSO and IOD with Indian summer monsoon precipitation
5. Students can analyze and predict the climatological variables at different space-time scale

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two*

1. Components of the climate system, Role of the land surface in climate forcing: moisture transport from the surface to atmosphere in causing variation in precipitation.

2. Distribution of insolation and global energy balance model, radiative transfer model for energy transmission in the surface-atmospheric system.

3. Cloud physics: radiation-cloud interaction, cloud microphysics and its alteration due to different atmospheric conditions.

4. Atmospheric aerosols: sources, distribution and chemistry of aerosols; effect on weather and climate; radiative forcing study, estimation of green house effect.

5. Overview of global climate models and climate modelling; radiation and precipitation schemes; RCP scenarios and their implication as reported in IPCC AR6.

## GEO 303F.2: STATISTICAL CLIMATOLOGY

**Course Outcome:** This curse is designed to produce a deeper understanding of fundamentals of climate system. The course is distributed in three specific manners; the first unit contains basic principles of climate system and climate modelling, including some focus on the physics of cloud and aerosols in the atmosphere. The second unit deals with statistical methods to analyse the climate parameter toward understanding their dynamics at the global and regional scales. The third and fourth units deal with air sampling and data analysis using satellite data.

Learning outcomes: Upon the completion of this course,

1. Students can answer to the question of changing global surface temperature
2. Have the capacity to analyze the cloud-earth-energy-radiation system
3. Can analyze the changing relation of precipitation and atmospheric aerosols
4.Can analyze the long distance teleconnection of ENSO and IOD with Indian summer monsoon precipitation
5. Students can analyze and predict the climatological variables at different space-time scale

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two*

1. Climatologies of precipitation, temperature and aerosols; Estimation of SOI based on SST of Nino regions in equatorial Pacific; IOD based on SST of the eastern and western Indian ocean.

2. ISMR anomalies and their connection with ENSO/IOD and global surface temperature rise; madden-julian-oscillation (MJO).

3.AR/MA and ARIMA for time series forecasting of climate variables; the implication of EOF in climate study

4. Downscaling of GCM using statistical approach.

5. Machine learning application in climate study; seasonal, interannual and decadal scale variation of basic climatic parameters.

# ELECTIVE PAPER

## PAPER - C-GEO 304: ENVIRONMENTAL ISSUES AND MANAGEMENT FULL

**Marks: 50 Credit: 4**

### C-GEO 304.1: EMERGING ISSUES AND POLICIES ON ENVIRONMENT

**Course Outcome:** Students will develop their interest in various aspects of environment and contemporary environmental issues. Students will develop their deep understanding in the nature of increasing intensity and magnitude of various hazards in connection to global pattern of economic disparity, social discrimination and climate change.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Global climate change, water scarcity and politics of water.

2. Environmental degradation and pollution.

3. Environment and development: Debate and Issues.

4. Social and Cultural Hazards.

5. Globalization and Environment.

### C-GEO 304.2: ENVIRONMENTAL HAZARDS AND DISASTER MANAGEMENT

**Course Outcome:** Students will foster their skill in managing various types of natural hazards by analysing their risk and vulnerability. They will be trained in the procedures of hazard management through proactive approach by increasing the resilience of the community in tune with national policy of hazard management and international laws.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Concepts and techniques for analysis of risk, hazard, disaster, vulnerabilities and resilience.

2. Cyclone and storm surges, thunderstorms and lighting, earthquake, tsunami wave and landslide hazards.

3. Natural hazard and disaster management in India, Agricultural drought hazard and the national experience.

4. International Disaster Response Laws Rules (IDRL).

5. National policy and appraisal of hazard.

# PRACTICAL COURSES (100 Marks)

## SEMESTER-III

## PAPER – GEO 395: FIELD WORK IN GEOGRAPHY

**Full Marks: 50 Credit: 4**

### GEO 395.1: FIELD WORK AND COMMUNITY OUTREACH

**Course Outcome:** This course aims to present the essence of **geography as a field science**. Students will develop their aptitude in observation, data generation through field survey, data analysis with various software and advanced techniques. They will also know how to represent spatial data through various cartographic techniques and mapping. A hands on practical training is practiced through rigorous involvement in all the stages of pre-field, field and post field works.

### GEO 395.2: FIELD REPORT (AS PER SPECIAL PAPER)

**Course Outcome:** This course aims to present the essence of geography as a field science. Students will write their field report as per the field work conducted under different special papers. All types of database management and data analysis with the application of software and aptitude gained in field work.

Generation of report (within about 100 A4 size pages including 30-40b maps/diagrams/field photographs) on the basis of field works carried out under Unit-47.

Presentation of research work-25 (Grand Viva-10 and/or Power Point presentation-15)

## PAPER – GEO 396: ADVANCED QUANTITATIVE METHODS AND DIGITAL CARTOGRAPHY

**Full Marks: 50 Credit: 4**

### GEO 396.1: ADVANCED QUANTITATIVE METHODS

**Course Outcome:** The course, split into two units, corresponds to the basic and advance statistics, is a starting point of escalating the statistical analytical skills. It includes the founding concepts of probability distribution including the advanced linear modelling with matrix solution to the multivariate linear and non-linear model. These concepts are essential for augmenting the analytical skills of any beginner in Geography that includes both physical and social aspects of academic discipline. Upon completion of this course, the students get the benefit of having a strong mathematical and statistical analytical skill.

*Full Marks- 25*
*Pattern of Setting Questions: Three compulsory questions bearing marks 7, 7 and 6 respectively, will be set covering the whole unit. 5 marks will be allotted for Laboratory Note Book and Viva-voce.*

1. Analysis of Variance: Objectives; One-way and Two-way ANOVA

2. Fitting Second Degree Polynomial curves to bivariate geographical data and testing by ANOVA.

3. Multiple Regression: Linear multiple regression equation, Multiple and partial correlation coefficient.

4. Elementary multiple regression modeling techniques: Stepwise variable entry method, Path Analysis.

5. Statistical model building techniques

## GEO 396.2: GIS, DIGITAL CARTOGRAPHY, AND GEODESY

**Course Outcome:** The course is designed for providing the fundamental ideas of Geodesy and map projection. It includes some advance projective transformation from 3D to 2D surface. The course also includes the fundamentals of GI science and its application. The students get an exposure to the theoretical and practical understanding upon completion of this course.

*Full Marks- 25*
*Pattern of Setting Questions: Three compulsory questions bearing marks 7, 7 and 6 respectively, will be set covering the whole unit. 5 marks will be allotted for Laboratory Note Book and Viva-voce.*

1. Principle, construction, properties and uses of following map projections: a) Conformal Projections- Mercator's Projection; Transverse Mercator Projection and Lambert's Conformal Conic (LCC) Projection.

2. Principle, construction, properties and uses of following map projections:Equal Area Projection- Mollweide's Projection ;Conical Projection- Simple Conical Projection with Two Standard Parallels.

3. Geodesy and Coordinate Systems: Concept of Geoid, ellipsoid and datum, Cartesian, and geographic coordinate system, UTM Grid System.

4. Basics of GPS Surveying: Conceptual Framework, Space Segment, Ground Segment, Control Segment, Satellite Triangulation, Pseudo Random Code.

5. Fundamental principles DGPS, global navigation systems, Implication of locational and spatial attributes in GIS and remote sensing.

# SUGGESTED REFERENCES

## GEO 301.1: ENVIRONMENTAL ENGINEERING


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Vesilind, P.A. and Morgan, S.M. (2004): Introduction to Environmental Engineering (2nd Edition), Thomson, Australia.


## GEO 301.2: ENERGY, WATER AND FOOD NEXUS


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Goals, S. D., & Hill, C. (2016). The Water, Food, Energy and Climate Nexus. In The Water, Food, Energy and Climate Nexus. https://doi.org/10.4324/9781315640716

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Harvey Danny(1999): Global Warming:, Pearson Education India

Mike Gonzalez, MarianellaYanes(2015): The Last Drop-The Politics of Water, Pluto Press,Wendy Nelson Espeland (2015): The Struggle for Water: Politics, Rationality, and Identity in theAmerican Southeast, University of Chicago Press

Paolo F. Ricci (auth.) ( 2006): Environmental and Health Risk Assessment and Management: Principlesand Practices, Springer Netherlands

Marquita K. Hill (2010): Understanding Environmental Pollution, Cambridge University Press

Chris Barrow (2005): Environmental Management and Development. Routledge

Andrew E. Collins, Jones Samantha, Bernard Manyena, JanakaJayawickrama, (2014): Hazards, Risks, andDisasters in Society, Elsevier

Fred Krüger, Greg Bankoff, Terry Cannon, BenediktOrlowski, E. Lisa F. Schipper(2015): Cultures andDisasters: Understanding Cultural Framings in Disaster Risk Routledge

Peter Christoff, Robyn Eckersley: Globalization and the Environment, ,Rowman and Littlefield ,Newyork


## C -GEO 304.2: ENVIRONMENTAL HAZARDS AND DISASTER MANAGEMENT


Alexander, D. (1993): Natural Disasters, Research Press, New Delhi: 619p.

Baarrsches, W.H. (1996): Eco-facts and Eco-fiction: Understanding the Environmental Debate, Routledge,

London. Chapman, D. (1994): Natural Hazards, Oxford University Press, Melbourne: 174p.

Dasgupta, P. and Mller, K.G. (1997): The Environment and Emerging Development Issues, Volumes I and 2, Clarendon

Elsom, D.M. (1992): Atmospheric Pollution: A Global Problem, 2nd edition, Blackwell Pub. Co., London: 422p.

Farmer, A. (1997): Managing Environmental Pollution, Routledge, London: 246p.

Hyndman, Donald and Hyndman, David. (2008): Natural Hazards and Disasters; Cengage Learning.

Keller, Edward A. and Blodgett,Robert H. (2007): Natural Hazards: Earth's Processes As Hazards,

Disasters and Catastrophes; Pearson Prentice Hall.
Middleton N. (1995): The Global Casino: An .Introduction to Environmental Issues, John Wiley and Sons. New
Park, C. 1998: The Environment: Principles and Applications, Routledge, London:York: 332p.
Pickering, K. and Owen, L.A. (1997): An Introduction to Global Environmental Issues, 2nd edition, Routledge, London:
Roberts, N. (editor) (1994): The Changing Global Environment, 3rd edition, Blackwell Pub. Co., London: 531 p.
Smith, Keith and Petley, David N. (2009): Environmental Hazards: Assessing Risk And Reducing Disaster; Taylor & Francis.
Valancy, F. and Bronstein, D.A. (1995): Environmental and Social .Impact Assessment, John Wiley and Sons inc., New York: 325p.
Vogler, J. (1995): The Global Commons: A Regime Analysis, John Wiley and Sons Ltd., Chichester: 233p.

## GEO 395.1: FIELD WORK AND COMMUNITY OUTREACH

Compton,R.R.(1985): Geology in the Field, John Wiley and Sons.
Gardiner,V. and Dacombe,R.(1983): Geomorphological Field Manual, George Allen and Unwin, London
Goudie, A.(1981): Geomorphological Techniques, George Allen and Unwin, London
Kothari,R.C(2004):Research Methodology, New Age International Publishers, New Delhi.
Mahmood, A (1977): Statistical methods in Geographical studies, Rajesh Pub. New Delhi
Mathur,S.M (2001): Guide to Field Geology, Prentice Hall, India
Mishra,H.N (1998): Research Methodology in Geography, Rawat Publication.
National Family Health Survey (NFHS-3) 2005-2006, Vol-I and II International Institute for populationScience,Mumbai
Pal, S.K. (1999): Statistics for Geoscientists, Concept publishing Company, New Delhi: 423p.
Ramachandran, P.(1971):Training in Research Methodology in Social Sciences in India, ICSSR, NewDelhi
Shama,B.A.V. et al (1983): Research Methods in Social Sciences, Chaitanya Publishing House, Allahabad

## GEO 395.2: FIELD WORK (AS PER SPECIAL PAPER)

Goudie, A.(1981): Geomorphological Techniques, George Allen and Unwin, London
Mathur,S.M(2001): Guide to Field Geology, Prentice Hall, India
National Family Health Survey (NFHS-3) 2005-2006, Vol- I and II International Institute for populationScience,Mumbai
Pal, S.K. (1999): Statistics for Geoscientists, Concept publishing Company, New Delhi: 423p.
Ramachandran, P.(1971):Training in Research Methodology in Social Sciences in India, ICSSR, NewDelhi
Shama,B.A.V. et al (1983): Research Methods in Social Sciences, Chaitanya Publishing House, Allahabad.

## GEO 396.1: ADVANCED QUANTITATIVE METHODS

Aralinghaus,S.L and Griffity, A.(1995): Practical Handbook of Spatial Statistics, CRC Press

Brien, O.L. (1992): Introducing Quantitative Geography: Measurement, Method and Generalized linear Models, Routledge.

Clark, W.A.V and Hosking, P.L. (1986): Statistical Methods for Geographers, Wiley and Sons.

Fotheringham, S. A and Brunsdon, C and Charlton, M. (2000): Quantitative Geography: Perspectives on SpatialData Analysis, SAGE.

Haining, R.P. (2003): Spatial Data Analysis, Cambridge University Press.

Lindsay, J.N. (1997): Techniques in Human Geography, Routledge

## GEO 396.2: GIS, DIGITAL CARTOGRAPHY, AND GEODESY

Kraak, M.J. and Ormeling, F. (2004): Cartography- Visualization of Geospatial Data; Pearson Education, Singapore.

Maling, D.H. (1973): Co-ordinate systems on Map Projection; George Philip and Sons Ltd, London

Raisz, E. (1962): Principles of cartography; Mc Graw Hill, NY.

Richards, P. and Adler, R.K. (1974): Map Projections, North Holland Publishing Company, New Delhi.

Robinson, A.H., Sale, R.D., Morrison, J. (1984): Elements of Cartography, Wiley, New York:

Roy, P. (1988): An Analytical Study of Map Projections, Volume 1, Kolkata.

Sarkar, A. (1997): Practical Geography: A Systematic Approach, Orient Longman Ltd., Hyderabad:

Steers, J.A. (1965): An Introduction to Map Projections, 14th ion, University of London Press, London:

# Semester- IV (300 Marks)

## THEORETICAL COURSES (200 Marks)

### PAPER – GEO 401: DISSERTATION REPORT AND VIVA-VOCE

**Full Marks: 100 Credit: 8**

**GEO401.1: Problem Selection and Methods of Study**

**GEO401.2: Field Investigation and Database generation**

**GEO401.3: Data analysis and Report Writing**

**GEO401.4: Presentation and Viva-Voce**

### PAPER – GEO 402: TOURISM AND GENDER GEOGRAPHY

**Full Marks: 50 Credit: 4**

**GEO 402.1: TOURISM GEOGRAPHY**

**Course Outcome:** This course aims to present the essence of geography as it relates to tourism, geo-environmental and economic aspects. Students will develop their employability aptitude through guiding tourists in the sensitive environment and can also estimate the income generation from tourism and recreational activities. The students can also assess the impacts of tourism and recreational activities on the environmental components. The diversity of tourism activities in different landscapes will be learned by the course. Data analysis with various software and advanced techniques on tourism statistics can be generated by the course.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1.The supply of Recreation and Tourism: The supply of tourism industry and the destination life cycle; Geography of Tourism production; The role of the public and private sector in Tourism supply; spatial analytical approaches to the supply of tourism facilities

2.Impacts of Tourism and Recreation: Positive and Negative dimensions of the impacts of tourism on host communities; carrying capacity assessment for tourist destinations with methodology; The limits of acceptable change in wilderness areas of Island territory in India; The analysis of tourism's social impacts

3. Coastal and Mountain Recreation and Tourism: The historical analysis of recreation and tourism in the coastal zone; Environmental perspectives on coastal recreation and tourism, Perspectives of mountain tourism in India; Cultural tourism practised in the mountain Himalaya

4.Geo-diversity, Geo-restoration, Geo-tourism and Leisure Activities: Archaeological and historical value of Geo-diversity; Threats to Geo-heritage; Geo-restoration of wilderness and National parks; Wetland restoration and landscape design; Geo-tourism significances of landscapes for leisure activities; scenic assessment of tourism destination sites.

5. Tourism and Recreation Planning and Policy: Approaches to Tourism planning for leisure; Rural tourism development policy instruments; Tourism policy: Goa; Himachal Pradesh and Uttarakhand; Odisha; West Bengal

## GEO 402.2: GENDER GEOGRAPHY AND ENVIRONMENT

**Course Outcome:** On the successful of completion of this course, students will be able to comprehend and analyse key texts within the field of gender and environment from the fields of, geography. Student will be able to understand the role of gender identities in use, ownership and management of land and other natural resources. This course will help them to conceptualize interdisciplinary nature of the subject with a gendered perspective and feminist epistemologies. Students will be able to comprehend contemporary social transformations throughout their lives with sensitivity, empathy and through the lens of gender justice.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Conceptualizing Gender Geography: Social construction of the feminine and masculine, Development of and theoretical approaches to the study of Gender in geography; Examining Gender in relation to space: Division of space in to private and public spaces, Gendered environments,

2. Spatial Patterns and modes of Gender discrimination and inequalities: Patriarchy, Matriarchy, Matriliny and Matrilocality, Social space and gender, creation of gendered space and reproduction of gendered space, gender stereotypes and representation; Gender disparities in education and health: The Indian situation

3. Women in Resource Management: Women-Nature-Development debate, Development and depletion of natural resources; Environmental degradation and pollution, Vulnerability of women in resource extraction

4. Women and Quality of life: Women and human development status: Human rights and legal space for women: Quality of life in urban and rural areas , Poverty of rural women , Food-Fuel-Water Crisis; occupational hazards , Glass Ceiling- Indian context, GEM and GDI, Crime against women

5. Role of Women in Environment Conservation: Chipko Movement, Women Environmentalists and their Contribution: Rachel Carson, Vandana Shiva, Padmashri Tulsi Gowda and Nobel laureate Wangari Muta Maathai.

# PAPER – GEO 403: SPECIAL PAPERS

**Full Marks: 50 Credit: 4**

## 403A: ADVANCED GEOMORPHOLOGY

### GEO 403A.1: ADVANCED GEOMORPHIC TECHNIQUES

**Course Outcome:** Students will learn about the empirical methods to estimate various geomorphic attributes by using field instruments or through models run by sophisticated software. This will offer them training on data generation, computation and analysis. This course aims to enable learners deal with real world problems using advanced technology recently available to the department from DST-FIST programme, Department of Science and Technology, Govt. of India.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Modeling concepts and approaches in geomorphology; Data sources and Freeware models; Dating procedures and uses.

2. Estimating flow velocities, discharge and stage.; Estimation of stream hydraulic parameters (Critical flow, Froude number, Reynolds number). Inundation estimates.

3. Manning equation: Required data, data measurements, and limitations; Tractive force and stream power estimation.

4. Sediment transport and sediment discharge estimates: Bed load and suspended load.

5. Watershed delineation, preparation of DEM; micro-landscape analysis (landscape unit map) using GIS (Case study on a badland area).

### GEO 403A.2: APPLIED GEOMORPHOLOGY

**Course Outcome:** Students will learn how to apply theoretical knowledge of geomorphology in wide range of engineering and management problems ranging from drainage basin management to hazard management. They are trained to apply geomorphic understanding on water management, landuse planning, sewage and solid waste management. They are also trained on their contribution in EIA and EMP. This course aims in revival of the applied value of the discipline.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Applied Geomorphology in River Basin Management (Case study on Shilabati/ Kangsabati/ Subarnarekha Basin)

2. Applied Geomorphology in Hazard Management: Flood, Coastal and River Bank Erosion, Soil Piping, Soil Erosion (Case study on Shilaboti flood/ Old Digha Erosion/ Bhagirathi erosion, Western Ghat)

3. Geomorphology in dam site selection and impact assessment: (Case Study on Farakka)

4. Geomorphology in urban management: Landuse planning, Sewage treatment, Storm-water management, Ground water recharge and discharge (Case study on Kolkata)

5. Geomorphology in EIA and EMP (Case study on Nayachar/ Singur/Salboni)

## 403B: COASTAL MANAGEMENT

### GEO 403B.1: COASTAL ECOLOGY AND HAZARDS

**Course Outcome:** Students will understand the ecological importance of coast as an important habitat between terrestrial and marine system. They will also develop their deep insight into the significance and techniques of coastal study in the context of increasing hazards forced by global climatic change. They will be exposed to the information on the future scope of coastal studies in India.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Study and management of- Sea weeds; seaweed ecosystem, artificial seaweeds.

2. Dune vegetation: Dune initiating and dune building types, adaptation and reproduction, plant- animal interaction in sand dune. Mangroves: physical environment and ecology.

3. Coastal hazards and their management: Sea level change- long and short term changes, regional and global effects on shore; Coastal erosion- causes and effects; Storm hazard- role in sediment transfer, effects on open and estuarine coast, management of storm hazard.

4. Techniques of monitoring coastal processes and land forms.

5. Coastal studies in India: Monitoring and research.

### GEO 403B.2: COASTAL ISSUES AND MANAGEMENT

**Course Outcome:** Students will understand about the complexities of emerging coastal issues and their better management techniques. They will get employment opportunities as research scientist in the various institutes like INCOIS, MOEF, DST, NIO, NCSCM, Dept. of Earth Sciences and TOURISIM Department

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Coral bleaching: Impact of Global warming, coastal eutrophication and habitat conservation (Coastal lagoons, other coastal wetlands)

2. Coastal tourism and environment conflicts (Beaches and barrier coasts, mangrove dominated coasts, coral coasts, environmental regulations).

3. Application of remote sensing and GIS techniques in coastal management (Geomorphological mapping, coastal cell circulation systems, environmental zoning approach, identification and diversity of coastal habitats)

4. Managing coastal change: Assessment of coastal vulnerability, ecosystem valuation of coast, integrated coastal zone management, coastal regulations); Coastal engineering: Developments in hard structure designs, developments in soft structure designs, new dredging techniques and procedures.

5. Coastal urbanization and population pressures, Coastal resource management

## 403C: URBAN GEOGRAPHY AND REGIONAL PLANNING

### GEO 403C.1: THEORETICAL BASES OF REGIONAL PLANNING

**Course Outcome:** This paper will provide knowledge on spatial analysis of functions of urban areas. Social and economic characteristics of cities and suburbs will be discussed under this paper. Urban land use and its impact on environment and ecology will be addressed. This paper will introduce students to the basics of urban geography, such as definition of cities, central place theory, National urban systems, and traditional models of urban spatial structure. More importantly, students will be exposed to contemporary urban topics such as global cities, urban sprawling, urban green space, urban ecology and footprints etc. Emphasis will be placed on the urban experience of developing countries, especially India.The students will be able to assemble knowledge of urbanism and urbanization as historic, geographic, social, and cultural processes, historical development, contemporary condition, and

environmental impact of cities and urban related issues growing from exposure to the disciplines of Geography and Planning.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. History of regional planning in India, theories of regional planning. Concept of balanced and unbalanced growth

2. Regional development perspectives: Colonial period (Dependency theories- Friedman, Andre Gander Frank, David Slater)

3. Growth Pole theories and the developing world by Perroux, Myrdal, Hirschman, and Boudiville.

4. Agropolitan Development, Basic need approach (E.A.J Johnson, Dennis Rondinelli-USAID).

5. Regional Environmental issues in Purba and Paschim Medinipur Districts- Flood, Drought, coastal erosion, Salinization, Deprivation and related social conflicts, conflict in forest society interface.

**GEO 403C.2: PLANNING FOR URBAN DEVELOPMENT**

**Course Outcome:** Students will understand the urban planning process in various issues like sanitation, transport, housing, water supply etc and various policies of the govt. The knowledge about the remote sensing and GIS is also important for urban planning. The students will be able to participate in various works relating to urban planning.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Concept of developed and underdeveloped economy, Intra- and Inter-regional planning. Policies of Urban planning and development.

2. Urban infrastructure planning: Sanitation and Water supply systems, Waste Water disposal systems, Solid waste collection and disposal.

3. Urban traffic and transportation planning.

4. Planning for Urban housing: concepts of land use and land valuation, Needs and types of housing; Housing Policy and programmes in India; Real estate development.

5. Application of Remote Sensing and GIS in urban planning and management.

## 403D: REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

### GEO 403D.1: ADVANCED REMOTE SENSING

**Course Outcome:** This core content of this course is focused on some advanced ideas of microwave and hyperspectral remote sensing including image-based statistics for digital image processing. The course is also focused on some of the advanced ideas of GIS including remote sensing and GIS integration. It includes the application of GIS and remote sensing in various purposes. Upon completion of this course, students would be benefited from these advanced level of applications, and allow them to pursue their future career in GI Science.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Microwave Remote Sensing: Concept, advantages and disadvantages, spatial resolution, Real and Synthetic Aperture Radar, Passive Microwave Remote Sensing, Lidar.

2. Microwave Remote Sensing, Sensor:Landsat VS Sentinel data analysis, Radar interferometry, Differential interferometry, Polarimetry, and SRTM

3. Hyperspectral: concept, sensors, reflectance spectra, spectral library.

4. Digital image pre-processing: Geometric corrections, atmospheric corrections.

5. Digital image post-processing: image statistics, image enhancement and rectifications, signature separability index, image classifications, and transformation.

### GEO 403D.2: ADVANCED GIS AND APPLICATIONS OF REMOTE SENSING

**Course Outcome:** This core content of this course is focused on some advanced ideas of microwave and hyperspectral remote sensing including image-based statistics for digital image processing. The course is also focused on some of the advanced ideas of GIS including remote sensing and GIS integration. It includes the application of GIS and remote sensing in various purposes. Upon completion of this course, students would be benefited from these advanced levels of applications allow them to pursue their future career in GI Science.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Spatial data models: raster and vector data models, data sources, attribute data and metadata concepts, components of GIS, mobile and web GIS technologies. SQL for data mining, mathematical and logical operations using raster and vector data in GIS/image processing software platforms.

2. Digital Elevation Model: DSM, DTM; Calculation of Slope and Aspect for watershed analysis.

3. Remote sensing of vegetation; satellite-based applications for mapping vegetation, including agricultural land, vegetation health, and leaf water content assessment.

4. Remote sensing of soil and water; soil moisture estimation, estimation of suspended sediment load in the river and coastal waters.

5. Remote sensing of the atmosphere; retrieval of precipitation from satellite data, retrieval of cloud and aerosol optical depth from optical images.

## GEO 403E: SPATIAL ANALYSIS IN LANDSCAPE ECOLOGICAL DYNAMICS

### GEO 403E.1: LANDSCAPE ECOLOGY AND DYNAMICS

**Course Outcome:** This course will help the students to recognize the spatial patterns and heterogeneous environments are critical factors in understanding how systems work across a range of scales. It will provide concepts and theories which will help them in understanding the dynamics of complex systems. Finally this course will serve as foundations for decision-making and problem solving in applied fields such as conservation biology, land-use management, and urban planning and development.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Concepts of Landscape dynamics: Landscape dynamics on multiple scales, landscape sensitivity, landscape ecology and global change

2. Landscape pattern formation: Physical and Biotic processes; Drivers of Landscape Patterns, characteristics of landscape with emphasis on Forest and Urban landscape.

3. Landscape dynamics and drivers: climatological, topographical, socio-economical, biophysical, landscape composition and configurations.

4. Patterns of landscape change in forest landscape; Landscape in species perspective- Landscape contour model; Pattern-based landscape models;

5. Patterns of landscape change in Urban areas: Urban sprawl, congestion, urban ecology; concept, pattern and directions, GIS techniques for measuring composition and configuration; Fractal Geometry of Landscapes in the urban areas.

## GEO403E.2: SPATIAL ANALYSIS, LANDSCAPE MODELING AND SERVICES

**Course Outcome:** This course will help the students to synthesize the dominant themes of landscape ecology and Familiarize students with current research trends in the field and Explore applications from the landscape approach. The course is expected to be useful for the students understanding natural resources, ecology, conservation biology, landscape architecture, geography, land use planning, and other fields.

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Field works in Landscape Ecology; Bio-monitoring and Bio-indicator measuring using techniques Remote Sensing sensor and ecological data

2. Application of GIS techniques for landscape modeling : ArcGIS tools for connectivity and corridor modelling, habitat modelling and linkage design

3. Computation of landscape metrics using FRAGSTATS.

4. Introduction to Spatial Modelling Environment (SME), Unit model development in STELLA,; Landscape disturbance-succession models ,simulation models ; Urban change detection and prediction using CA-Marcov model.

5.Basic services of urban and forest ecosystem: Forest covers depletion, Causes and impacts on ecosystem services; Native/natural forest cover loss and overall forest loss

# GEO 403F: APPLIED CLIMATOLOGY

## GEO 403F.1: APPLIED CLIMATOLOGY-1

**Course Outcome:** This curse is designed to produce a deeper understanding of fundamentals of climate system. The course is distributed in three specific manners; the first unit contains basic principles of climate system and climate modelling, including some focus on the physics of cloud and aerosols in the atmosphere. The second unit deals with statistical methods to analyse the climate parameter toward understanding their dynamics at the global and regional scales. The third and fourth units deal with air sampling and data analysis using satellite data.

Learning outcomes: Upon the completion of this course,

1. Students can answer to the question of changing global surface temperature
2. Have the capacity to analyze the cloud-earth-energy-radiation system
3. Can analyze the changing relation of precipitation and atmospheric aerosols
4. Can analyze the long distance teleconnection of ENSO and IOD with Indian summer monsoon precipitation
5. Students can analyze and predict the climatological variables at different space-time scale

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Air sampling and analysis process for studying inorganic chemistry of the atmosphere, Inorganic chemistry of rainwater with its source attribution: spectroscopic principle.

2. Analysis of the vertical profile of the atmosphere through cloudSat and Calipso sensor data

3. Estimation of PBLH through radiosonde data; other data sources of PBLH; the implication of PBLH in weather and climate studies.

4.Distort Atmospheric Radiative Transfer (DART) and Optical Properties of Aerosols and Cloud (OPAC) models for studying atmosphere and radiation interaction

5. Changing water cycle: global and regional constraints of water cycle, observed changes of water cycle based on multiple dataset.

**GEO 403F.1: APPLIED CLIMATOLOGY-2**

**Course Outcome:** This curse is designed to produce a deeper understanding of fundamentals of climate system. The course is distributed in three specific manners; the first unit contains basic principles of climate system and climate modelling, including some focus on the physics of cloud and aerosols in the atmosphere. The second unit deals with statistical methods to analyse the climate parameter toward understanding their dynamics at the global and regional scales. The third and fourth units deal with air sampling and data analysis using satellite data.

Learning outcomes: Upon the completion of this course,

1. Students can answer to the question of changing global surface temperature
2. Have the capacity to analyze the cloud-earth-energy-radiation system
3. Can analyze the changing relation of precipitation and atmospheric aerosols
4.Can analyze the long distance teleconnection of ENSO and IOD with Indian summer monsoon precipitation
5. Students can analyze and predict the climatological variables at different space-time scale

*Full Marks- 25 (End term Examination- 20 and Internal Assessment- 5)*

*Pattern of setting questions:* ***Group- A*** *(Long Answer Type): Two questions, each of* ***8 marks*** *(without division), will be set for answering any one.* ***Group- B*** *(Semi-long Answer Type): Four questions, each of* ***4 marks*** *(without division), will be set for answering any two.* ***Group- C*** *(Short Answer Type): Four questions, each of* ***2 marks*** *(without division), will be set for answering any two.*

1. Global and regional scale climatological data sources: ECMWF, CRU, NCAR, APHRODITE, IMD-gridded products.

2. Studying clouds using satellite imagery; cloud fraction, cloud height, cloud top pressure and temperature and cloud effective radii

3.Studying global and regional scale aerosol loading using satellite-derived products with the help of CDO, R, Python languages; aerosol-cloud-precipitation interaction: regression analysis

4. Extreme weather events: causes and measurements.

5. Fundamentals of HYSPLIT trajectory modelling, Data sources of air mass trajectory, Trajectory analysis: potential source contribution function (PSCF) and clustering.

# PRACTICAL COURSES (100 Marks)

## SEMESTER-IV

## PAPER – GEO 495: ENVIRONMENTAL ASSESSMENT AND SPATIAL ANALYSIS IN GEOGRAPHY

**Full Marks: 50 Credit: 4**

### GEO 495.1: ENVIRONMENTAL MONITORING AND ASSESSMENT

**Course Outcome:** Students will develop practical skills for constructing various experiments and environmental maps and foster their abilities in showing the spatial distribution of various environmental elements and their proper interpretation. This ability will help them to formulate environmental plans and to manage and conserve vegetation, air, soil, water etc.

*Full Marks- 25*

*Pattern of Setting Questions: **Three** compulsory questions bearing marks **7, 7 and 6** respectively, will be set covering the whole unit. **5** marks will be allotted for Laboratory Note Book and Viva-voce.*

1.Determination of Particle Size using respirable dust sampler, Determination of PM 2.5 and PM 10 using Fine Particle Sampler; Estimation of Dust retaining capacity of plants.

2. Estimation of Formaldehyde (HCHO) and Sulphur dioxide by Calorimetric method.

3. Measurement of Noise.

4. Estimation of Chlorophyll, total organic, inorganic carbon.

5. Site Visit to degraded landscape/habitat/Industrial site for related pollution monitoring and EIA.

### GEO 495.2: SPATIAL ANALYSIS IN GEOGRAPHY

**Course Outcome:** The focus of this course is to give a comprehensive understanding of the spatial organization through mathematical and statistical analysis. Upon completion of this course, the students get an inclusive knowledge and skills to perform spatial analysis at different spatial scale.

*Full Marks- 25*

*Pattern of Setting Questions: **Three** compulsory questions bearing marks **7, 7 and 6** respectively, will be set covering the whole unit. **5** marks will be allotted for Laboratory Note Book and Viva-voce.*

1. Transport network analysis: Centrality Indices, Shortest path analysis (Transport and allocation problems), Detour and spread.

2. Distance Matrix (Aggregate Travel Distance).

3. Point spatial distribution analysis: Uniformity, randomness and compactness.

4. Analysis of Directional Data; Rose diagram, Dominant Direction, Mean direction.

5. Analysis of Shape: Measures based on axial ratios, perimeters to areas, areas to axial length.

## PAPER – GEO 496: RESEARCH ETHICS AND SPATIAL MODELING IN GEOGRAPHY

**Full Marks: 50 Credit: 4**

### GEO 496.1: PROPOSAL WRITING & RESEARCH ETHICS

**Course Outcome:** The learners will get the initial training on various steps involved in geographical research. They will develop the idea on fundamentals of research methodology including data collection, methodology and report writing. This course aims to develop fundamental research aptitude among all the students

*Full Marks- 25*

*Pattern of Setting Questions: **Three** compulsory questions bearing marks **7, 7 and 6** respectively, will be set covering the whole unit. **5** marks will be allotted for Laboratory Note Book and Viva-voce.*

1. Research ethics and paradigm shift of research methodology in Geography.

2. Need for research, basic research types.

3. Identification of research problems, development of theoretical background- literature review, research gap and research question and specification of the objectives of study; hypothesis building, Framework of research writing.

4. Methods of data collection- primary and secondary; Preparation of questionnaire and survey schedule and their differences, research ethics.

5. Methods of writing notes, style of referencing, bibliography and appendices, abstract and synopsis writing.

### GEO 496.2: SPATIAL MODELING

**Course Outcome:** This course will provide the students with a range of techniques for analysing and modelling spatial data to build upon the more general research training delivered via companion modules on data collection and data analysis, both of which have a spatial focus. It will also highlight a number of key social issues that have a spatial dimension, as well as explain the specific challenges faced when attempting to analyse spatial data. The course also introduces a range of analytical techniques and approaches suitable for the analysis of spatial data and enhances practical skills in using R software packages to implement a wide range of spatial analytical tools.

*Full Marks- 25*

*Pattern of Setting Questions: **Three** compulsory questions bearing marks **7, 7 and 6** respectively, will be set covering the whole unit. **5** marks will be allotted for Laboratory Note Book and Viva-voce.*

1. Basic Concepts and components in GIS, Spatial data model, Geostatistical, Spatial features, Overlay analysis in ArcGIS, and other open-source packages

2. Database creation, climate forcings, soil and LULC

3. Morphometric analysis in ArcGIS

4. SWAT hydrological model with ArcSWAT

5. Model calibration principal and validation with SWAT-CUP

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