Syllabus
for
M.Sc. in Geography
(Under NEP 2025)

EFFECTIVE FROM THE ACADEMIC SESSION 2025-2026

Department of Geography
Vidyasagar University
Midnapore, Paschim Medinipur,
West Bengal PIN – 721102

Programme Name: Post-Graduate course (M. Sc.) in Geography

Programme Outcomes (POs)

After completion of the post-graduate programme in Geography students will develop the following skills and abilities that foster their quest for further knowledge, aptitude of critical thinking, problem solving capacities and practical application to real world situations and thus promote employability**.**

PO 1	**Comprehensive and holistic understanding of geographical phenomena and their interactive assemblage**	Students will demonstrate a comprehensive and advanced understanding of systematic interaction among both physical and social phenomena operating within physical and cultural landscape at local as well as global scale. This includes knowledge of major theories, concepts, and contemporary developments across all the geographical subfields
PO 2	**Critical thinking and analysis of the contemporary geographical issues**	Students will nurture advanced critical thinking practices on the contemporary geographical issues through synthesizing information from diverse sources, skill of evaluating competing ideas, and abilities of interpreting complex phenomena at varied spatial and temporal contexts.
PO 3	**Effective communication**	Graduates will get rigorous training on written, oral, and visual communication skills for effective demonstration of complex geographical phenomena and emerging issues to scientific community as well as common people. It includes the skill of writing scholarly reports and scientific articles, and delivery of convincing presentations.
PO 4	**Advanced research skills**	Students will be trained in research methodology including the skill of formulating research questions, using state-of-art methods and ethical issues in various steps of research and advanced statistical techniques for interpreting data. Thus, the students will develop the capacity to conduct independent research projects using cutting-edge qualitative and quantitative methods.
PO 5	**Expertise in geospatial technology**	Students will be highly proficient in modern geographical tools and techniques and digital cartography. They will be trained in Geographic Information Systems (GIS), Remote Sensing (RS), and Global Navigation Satellite Systems (GNSS).
PO 6	**Ethics**	Graduates will acquire rigorous understanding on the importance of geography in promoting ethical issues in assessing man-nature relationship, regional disparity, gender issues, climate change impacts and adaptation initiatives, , water sharing conflicts, spatial variation in poverty, crime etc. They will also get adequate training on ethical issues at different steps of geographical research and publication.

PO 7	**Environment and sustainability**	The programme fosters an understanding of environmental issues resulting out of complex interactions between human societies and the physical environment. They will be thoroughly trained to systematically evaluate issues of environmental degradation and pollution, resource depletion, biodiversity loss, landscape ecology etc. They will be trained in environmental management through proper engineering techniques, Sustainable Development Goals (SDGs) and the challenges of achieving sustainability.
PO 8	**Applied Skill and Practical Aptitude**	The graduates will be equipped with the application of geographical knowledge and skills to identify, analyse contemporary and complex societal and environmental issues and problems and propose solutions for them. This includes issues related to hazards and disaster, regional development, climate change, resource management, poverty, crime, environmental degradation, and sustainable development.
PO 9	**Fieldwork and experiential learning**	Students will be carefully trained on practical and hands-on experience by conducting field surveys and dissertation projects focusing on relevant environmental and social issues. This help them to develop observation skills, promotes ability of having deeper understanding of ground realities, and exposes students to multi-dimensions of a particular socio-environmental problem.
PO 10	**Lifelong learning and professional development**	The programme get the students ready for independent and lifelong learning in geographical issues that are continuously changing due to constant evolution of society, environment and technology. This programme also aims to prepare the learners for professional careers in academia, various policy making bodies under government sectors like, urban planning, environmental management, resource allocation and management etc .

Programme Specific Outcomes (PSOs)

After completion of this programme learners will achieve the following Programme Specific Outcomes (PSOs):

PSO 1. Advanced knowledge in Geography

Graduates will develop a comprehensive and advanced knowledge on various sub-disciplines of geography. They are encouraged to read recently published standard text books. Syllabus covers almost all the major sub-fields of geography.

PSO 2. Specialised geographical knowledge

Students will cultivate thorough and specialized knowledge in different discourses of geography, such as geomorphology, climatology, urban and regional planning, landscape ecology, and remote sensing and

GIS. This will facilitate them in pursuing advanced study and specialised research and allows them in effective contribution to planning and policy making.

PSO 3. Application of geographical knowledge to real-world problems

Every theoretical course is supplemented with a practical course to make the graduates able to synthesize geographical knowledge and apply this to solve complex real-world challenges like climate change impacts and resilience issues, resource management, poverty, crime, Environmental degradation and pollution, disaster management, and sustainable development etc.

PSO 4. Expertise in geospatial technologies

Graduates will be equipped with the expertise in using advanced geospatial tools and techniques, such as Geographic Information Systems (GIS), Remote Sensing (RS), and Global Navigation Satellite System (GNSS), for data acquisition, analysis, and mapping.

PSO 5. Ability to conduct independent geographical research

Syllabus is loaded with assignments, practical, dissertation projects, field reports and research methodology to prepare the graduates with the skills required for doctoral research and independent researcher. Students will become experts in identifying research gap, formulating research question, design methodologies, collect required data, analyse and represent them to produce high-quality research.

DIVISION OF MARKS

Total marks: 1100

Department Specific Core Course				Department Specific Elective		Indian Knowledge System/Social Service / Community Engagement Skill Enhancement Course	MOOC Course	Total
Semesters	**Theory**	**Practical**	**Total**	**Theory**	**Practical**			
Semesters-I	105	45	150	100		25	-	275
Semesters-II	70	30	100	150		25	-	275
Semesters-III	35	65	100	50	50	25	50	275
Semesters-IV	35	165	200	50		25		275
Total	245	305	**550**	**350**	**50**	**100**	**50**	**1100**

STRUCTURE OF SYLLABUS

SEMESTER-I
(Duration: July – December)

SEMESTER-I						
Discipline Code	**Paper Code**	**Paper**	Marks			**Credits**
			End-term Exam.	**Internal Exam.**	**Paper Total**	
DSC 1	GEOC401X1	Foundation of Bio-geography and Environmental Sustainability	**30**	**5**	**35**	**3**
	GEOC402X8	Thematic Mapping	**10**	**5**	**15**	**1**
DSE 1	GEOE402A0 *Or* GEOE402B0	Population Geography, Global Economic Crisis, Geopolitics *Or* Landscape Ecology and Planning	**40**	**10**	**50**	**4**
DSC 2	GEOC403X1	Research Methodology And Ethics	**30**	**5**	**35**	**3**
	GEOC403X8	Research Methodology And Ethics (Assignment)	**10**	**5**	**15**	**1**
DSE 2	GEOE404A0 *Or* GEOE404B0	Regional Geomorphology of India & West Bengal *or* Water Resource Management	**40**	**10**	**50**	**4**
DSC 3	GEOC405X1	Geotectonics & Geomorphology	30	5	35	3
	GEOC405X8	Sedimentology	10	5	15	1
IKS	GEOO406VC	Indian Knowledge System in Nature Conservation	20	5	25	2
NCC	GEOO407NC	Vidyasagar Life and Philosophy	Compulsory, Non-Credit Course (NCC)			
TOTAL					275	22

SEMESTER-II
(Duration: January – June)

SEMESTER-II						
Discipline Code	**Paper Code**	**Paper**	Marks			**Credits**
			End-term Exam.	**Internal Exam.**	**Paper Total**	
DSC 4	GEOC451X1	Geographical Thought & Environmental Ethics	30	5	35	3
	GEOC451X8	Spatial Analysis & Spatial Modelling	10	5	15	1
DSC 5	GEOC452X1	Hydrology & Oceanography	30	5	35	3
	GEOC452X8	Hydrological Techniques	10	5	15	1
DSE 3	GEOE453A0 Or GEOE453B0	Regional planning & Development *or* Settlement & Transport geography	40	10	50	4
DSE 4	GEOE454A0 Or GEOE454B0	Rural Development *or* Agricultural geography	40	10	50	4
DSE 5	GEOE455A0 Or GEOE455B0	Social & cultural geography *or* Gender, space and crime	40	10	50	4
SEC 1	GEOC456X9	Field Visit/ Industry Visit/Case Study/ Hands-on Practical/ Skill Enhancement Course: **Ecological Census Techniques**	25	-	25	2
TOTAL					275	22

SEMESTER- III

(Duration: July – December)

SEMESTER-III						
Discipline Code	**Paper Code**	**Paper**	Marks			**Credits**
			End-term Exam.	**Internal Exam.**	**Paper Total**	
DSC 6	GEOC502X1	Meteorology & Climatology	30	5	35	3
	GEOC502X8	Climate change assessment techniques	10	5	15	1
Special papers (students have to opt ONE paper from 302 A/B/C/D/E)						
DSE 6	GEOE503A0	Process Geomorphology	40	10	50	4
	GEOE503B0	Sustainable Urban Development and Planning-I	40	10	50	4
	GEOE503C0	Physical Basis of Remote Sensing	40	10	50	4
	GEOE503D0	Theories in Landscape Development	40	10	50	4
	GEOE503E0	Climate Science& Modelling	40	10	50	4
DSC 7	GEOC504X9	Statistics and cartographic techniques	40	10	50	4
DSE7	GEOE505X9	Special paper based fieldwork/ internship	50	-	50	4
MOOCs	GEOC501X0	MOOC course	40	10	50	4
SEC 2	GEOC506X9	Social service and community engagement	20	5	25	2
TOTAL					275	22

SEMESTER-IV

(Duration: January – June)

SEMESTER-IV						
Discipline Code	**Paper Code**	**Paper**	Marks			**Credits**
			End-term Exam.	**Internal Exam.**	**Paper Total**	
DSC 8	GEOC551X1	Environmental engineering and energy, water and food nexus	35	5	35	3
	GEOC551X8	Environmental monitoring and assessment	10	5	15	1
Special papers (students have to opt ONE papers against from 402 A/B/C/D/E)						
DSE 8	GEOE552A0	Advanced geomorphology	40	10	50	4
	GEOE552B0	Sustainable Urban Development and Planning-II	40	10	50	4
	GEOE552C0	Remote sensing and geographic information system	40	10	50	4
	GEOE552D0	Spatial analysis in landscape ecological dynamics	40	10	50	4
	GEOE552E0	Applied hydro-climatology	40	10	50	4
DSC 9	GEOC553X9	Application of geological and geomorphological mapping and RS & GIS	50	-	50	4
DSC 10	GEOC554X9	Research project/Dissertation	100	-	100	8
SEC 4	GEOC555X9	*Intellectual property right (IPR)/skill enhanced course (SEC)* Application of AI/ML in Geography or Environmental audit ISO:14001	25	-	25	2
TOTAL					275	22

SYLLABUS

SEMESTER-I (275 Marks)

PAPER - GEOC401X1 (DSC 1): FOUNDATIONS IN BIOGEOGRAPHY AND ENVIRONMENTAL SUSTAINABILITY

Full Marks 50 Credit 4

Course Outcome:

- Understand ecological and environmental principles by exploring interactions among living organisms and non-living components like soil, water, rocks, and atmosphere.
- Develop scientific and interdisciplinary problem-solving skills to analyze and address complex environmental issues effectively.
- Apply ecological concepts and methods in real-world contexts to support sustainable environmental decision-making and leadership.

Full Marks- 50 (End term Examination- 40 and Internal Assessment-10)
Pattern of setting questions: ***Group- A*** *(Long Answer Type):* ***FOUR*** *questions, each of* ***10 marks*** *(without division), will be set for answering any* ***TWO***. ***Group- B*** *(Semi-long Answer Type):* ***SIX*** *questions, each of* ***4 marks*** *(without division), will be set for answering any* ***THREE***. ***Group- C*** *(Short Answer Type):* ***EIGHT*** *questions, each of* ***2 marks*** *(without division), will be set for answering any* ***FOUR***.

Course content:

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
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
3. Population dynamics; factors leading to rarity, vulnerability and extinction of species, migration of species, patterns of survival, K and R selected species
4. Role of water, nutrient and energy in determining ecosystem process; concept of interspecific and intraspecific interaction, competition, niche and Keystone species, Flagship species
5. Biogeographic zones of India, Status of Biodiversity, Protected area Network, National Parks and Sanctuaries

PAPER - GEOC402X8 (DSC 1): THEMATIC MAPPING

Full Marks: 15 Credit: 1

Course Outcome:

Student will develop

- proficiency in cartographic skills to construct and interpret various thematic maps representing physical and social elements.
- Enhance the ability to analyze and depict the spatial distribution of diverse physical and social phenomena accurately.
- Foster holistic understanding by integrating spatial relationships between physical and social elements for comprehensive interpretation

Full Marks- 15
*Pattern of Setting Questions: **Two** compulsory questions bearing **5** marks **each**, will be set covering the whole unit. **5 marks** will be allotted for Laboratory Note Book and Viva-voce.*

Course content:

1. Mapping Agricultural Practices and Patterns: Techniques for mapping crop combinations, diversification, cropping intensity and spatial variability. Use of GIS and remote sensing tools to analyze agricultural landscapes.
2. Mapping Social Vulnerability and Disparities: Integrating demographic and socio-cultural data for comprehensive social mapping, Methods for mapping social vulnerability, ethnic groups, and social disparities
3. Assessment and Mapping of Social Well-being and Poverty: Estimation and mapping of key social indicators: Human Development Index (HDI), Gender Development Index (GDI), Gender Empowerment Measure (GEM).
4. Techniques for calculating and spatially representing Human Poverty Index (HPI-I and HPI-II) across developed and developing countries.

PAPER - GEOE402A0 (DSE 1): POPULATION GEOGRAPHY & GLOBAL ECONOMIC CRISIS, GEOPOLITICS

Full Marks: 35 Credit: 3

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.

- Students will develop their understanding on politics of space and spatial patterns of political and economic power distribution.
- 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- 35 (End term Examination- 30 and Internal Assessment- 5)
*Pattern of setting questions: **Group- A** (Long Answer Type): **TWO** questions, each of **10 marks** (without division), will be set for answering any **ONE**. **Group- B** (Semi-long Answer Type):**SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course content:

1. Population growth: logistic and exponential growth; Population composition and structure: Types, spatial and temporal variation and determinants of age, sex, literacy and rural-urban ratio, Population projection
2. Theories and approaches of population growth and regulation: Malthus, Marx and Neo-Malthusianism. Mobility transition model (Zelinsky), Theories of migration (Ravenstein, Lee)
3. Human development and gender issues: SDGs, HDI, GDI, GEM-concept, Contemporary Population issues and policies; population ageing, Maternal and Child health.
4. Concept of Liberalization, Privatization and Globalization (LPG),beginning of the globalization, globalization to glocalilisation.
5. Globalization and Economic Geography: Impact of globalization on agriculture, industry and trade; Globalization and cultural transformations.
6. World economic order: Economic booms and crisis, future of globalization. Globalisation and Geopolitics: Understanding relevance of Heartland and Rimland theory and the present-day geopolitics in the globalized world.

OR

PAPER - GEOE402B0 (DSE 1): LANDSCAPE ECOLOGY AND PLANNING

Full Marks: 50 Credit: 4

Course Outcome:

- Understand the core principles of landscape ecology, including spatial patterns, ecosystem interactions, and the effects of spatial heterogeneity on ecological processes.
- Develop skills to analyze and model landscape dynamics, such as detecting and simulating landscape changes and modeling populations or communities in landscape mosaics.
- Apply landscape ecology concepts professionally, preparing for careers in ecological research, environmental planning, and landscape management.

Full Marks- 50 (End term Examination- 40 and Internal Assessment-10)
*Pattern of setting questions: **Group- A** (Long Answer Type): **FOUR** questions, each of **10 marks** (without division), will be set for answering any **TWO**. **Group- B** (Semi-long Answer Type): **SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course content:

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

PAPER - GEOC403X1 (DSC 2): RESEARCH METHODOLOGY AND ETHICS

Full Marks: 35 Credit: 3

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 for data analysis and report writing.
- This course will foster fundamental research aptitude among the students

Full Marks- 35 (End term Examination- 30 and Internal Assessment- 5)
*Pattern of setting questions: **Group- A** (Long Answer Type): **TWO** questions, each of **10 marks** (without division), will be set for answering any **ONE**. **Group- B** (Semi-long Answer Type):**SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course content:

1. Paradigm shift of research methodology in Geography.
2. Need for research, basic research types. Research design in relation to philosophical approach.
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.

6. Research ethics: Ethical standards in data collection, Professional Ethics in conduct with co-researchers, Publication ethics

PAPER - GEOC403X8 (DSC 2): RESEARCH METHODOLOGY AND ETHICS

Full Marks: 15 Credit: 1

Course Outcome:

- This course will offer the initial hands-on training on various steps involved in geographical research.
- They will develop practical experience on fundamentals of research methodology including data collection, methodology for data analysis and report writing as well as preparing references using standard software.
- This course will foster fundamental research aptitude among the students

Full Marks- 15
*Pattern of Setting Questions: **Two** compulsory questions bearing **5** marks **each**, will be set covering the whole unit. **5 marks** will be allotted for Laboratory Note Book and Viva-voce.*

Course content:

1. Assignment on 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.
2. Assignment on methods of data collection- primary and secondary; Preparation of questionnaire and survey schedule and their differences, research ethics.
3. Assignment on methods of writing notes, style of referencing, bibliography and appendices, abstract and synopsis writing. Use of referencing software

PAPER - GEOE404A0 (DSE 2): REGIONAL GEOMORPHOLOGY OF INDIA & WEST BENGAL

Full Marks: 50 Credit: 4

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
- This course will generate interest on the unique characteristics and regional importance of physiographic regions.
- Students will develop their understanding on the distribution of geomorphic hazards in India and West Bengal and the criticality involved in their management.

Full Marks- 50 (End term Examination- 40 and Internal Assessment-10)

*Pattern of setting questions: **Group- A** (Long Answer Type): **FOUR** questions, each of **10 marks** (without division), will be set for answering any **TWO**. **Group- B** (Semi-long Answer Type): **SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course content:

1. Evolution of Landforms in India through tectonic history. Geological History of Bengal Basin
2. Geomorphology and soil-landform assemblages of Chhotanagpur Plateau and its adjacent areas of West Bengal.
3. Tectonics, drainage and geomorphology of Western Ghats with special reference to Deccan Trap.
4. Geomorphology of Darjeeling Himalaya and Terai Region.
5. Form, process and evolution of Ganga and Subarnarekha delta.
6. Geomorphic Hazards in India

OR

PAPER - GEOE404B0 (DSE 2): WATER RESOURCES MANAGEMENT

Full Marks 50 Credits 04

Course outcome:

This course provides an in-depth understanding of water resources management from a geographical perspective. Students will explore the distribution, availability, and utilization of water resources, as well as the challenges and strategies involved in managing water sustainably in reference to India. The syllabus covers theoretical concepts, case studies, and practical applications of water resources management.

- To comprehend the geographical distribution and availability of water resources in India.
- To analyze the socio-economic, political, and environmental factors influencing water resources management.
- To explore the challenges and conflicts arising from water scarcity, pollution, and climate change.
- To examine sustainable strategies, tools and best practices for water resources management.
- To develop critical thinking and problem-solving skills for addressing water-related issues.

Full Marks- 50 (End term Examination- 40 and Internal Assessment-10)
*Pattern of setting questions: **Group- A** (Long Answer Type): **FOUR** questions, each of **10 marks** (without division), will be set for answering any **TWO**. **Group- B** (Semi-long Answer Type): **SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course content:

1. Distribution and demand of water resources: Surface and Ground water resources distribution in India, factors affecting water availability (climate, topography, etc.), water demand and population growth, water scarcity and stress.

2. Water Resources Management: definitions, scope, principles and interdisciplinary nature. Significance of water resources management in socio-economic development
3. Challenges in water resource management: water quantity and quality, water-related disasters (floods, droughts, etc.).
4. Climate change and its impact on water resources, politics of water allocation and conflicts (national and international).
5. Sustainable Water Resources Management: integrated water resources management (IWRM), water conservation, reuse, restoration, and protection, Water Infrastructure.
6. Water Governance and Policy: tools and techniques of water governance (remote sensing and GIS, artificial intelligence, internet of things and participatory approaches), role of institutions and policies in managing water resources.

PAPER - GEOC405X1 (DSC 3): GEOTECTONICS & GEOMORPHOLOGY

Full Marks: 35 Credit: 3

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.
- 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.

- This course aims to inform the learners about the principles and physical settings on which geomorphic processes work to develop characteristic landforms.
- Students will learn about the mechanism and working principle of processes that lead to shape present earth-surface.
- Scope of application of geomorphic knowledge is explored. 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- 35 (End term Examination- 30 and Internal Assessment- 5)

*Pattern of setting questions: **Group- A** (Long Answer Type): **TWO** questions, each of **10 marks** (without division), will be set for answering any **ONE**. **Group- B** (Semi-long Answer Type):**SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course content:

1. Theory of the evolution of solar system. Relative and absolute dating: principles and techniques.
2. Origin of earth's magnetic field, paleomagnetism, geomagnetic polarity reversal and paleomagnetic timescale, paleomagnetic polar wandering curves and reconstruction of plate motions.
3. Mechanism of plate dynamics. Application of plate tectonic theory in explaining orogenesis, volcanism, earthquake. Neo-tectonics and its worldwide evidences.
4. Key Concepts in geomorphology: historical and functional approaches, geomorphic threshold, ideas of feedback, equilibrium, and boundary conditions.
5. Geomorphic Forms and processes: Weathering landforms. Mass wasting and slope forms and processes. Fluvial processes and forms.
6. Applied geomorphology in planning, hydrology and economic geology. Geomorphology in hazard Management (flood, landslide and subsidence) and EIA.

PAPER - GEOC405X8 (DSC 3): SEDIMENTOLOGY

Full Marks: 15 Credit: 1

Course Outcome:

- Students will develop aptitude and abilities on different methods of sediment sampling from the 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- 15
*Pattern of Setting Questions: **Two** compulsory questions bearing **5** marks **each**, will be set covering the whole unit. **5 marks** will be allotted for Laboratory Note Book and Viva-voce.*

Course content:

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

PAPER - GEOO406VC (IKS): INDIAN KNOWLEDGE SYSTEM IN NATURE CONSERVATION

Full Marks: 25 Credit: 2

Course Outcome

- Critically engage with Indian epistemologies on nature and ecology
- Evaluate community-based practices and their ecological relevance
- Apply IKS principles in geographical and environmental research
- Integrate indigenous frameworks into policy and academic discourse

Course content:

1. Traditional Indian Environmental Ethics and Practices: Ancient Indian philosophies (e.g., Vedic, Buddhist, and tribal perspectives) on nature, emphasizing harmony with ecosystems, sacred groves, and sustainable land-use practices.
2. Traditional Practices and Community Conservation Models : Sacred groves (*Devrai*, *Sarna*) and biodiversity hotspots Sacred rivers, mountains, and conservation ethics (e.g., Ganga, Himalayas), Traditional agro-ecological systems (e.g., Zabo, Apatani, Vedic agriculture), Water harvesting and irrigation traditions (e.g., stepwells, tanks, Johads), Folk religion, festivals, and ecological symbolism
3. Integrating Indian Knowledge with Modern Geospatial Tools and Contemporary Relevance: Application of traditional conservation insights using GIS, remote sensing, and landscape analysis to assess biodiversity hotspots, ecological corridors, and sustainable development planning.Contemporary Relevance and Integration with Modern Conservation

PAPER- GEOO407NC (NCC): VIDYASAGAR LIFE AND PHILOSOPHY

Full Marks: 25 Credit: 2

1. **Early Life and Education:** Birth and Lineage; A Journey from Iswar Chandra Bondopadhaya to lswar Chandra Vidyasagar.

2. **Vidyasagar and Indian Education:** The then Indian education system; Vidyasagarian plan for reformation of Indian education- Vidyasagar as teacher, Vidyasagar as writer, planner and reformer of Indian education.

3. **Vidyasagar and Women Emancipation**: Introduction of widow remarriage; Struggle to stop child marriage

4. **Philanthropist Vidyasagar:** Vidyasagars philanthropy as narrated by others

5. **Vidyasagar: Traditions and modernity**: Tradition; Modernity; Vidyasagara as Traditional moderniser

6. **Relevance of Vidyasagarian thoughts and values:** Vidyasagar and the then Society of Bengal; Lesson for future generations

SEMESTER- II (275 Marks)

PAPER - GEOC451X1 (DSC 4): GEOGRAPHICAL THOUGHT & ENVIRONMENTAL ETHICS

Full Marks: 35 Credit: 3

Course Outcome:

- The students will 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.
- Students will achieve a clear insight into the 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.
- Understand and explain key principles of environmental ethics, including the moral relationship between humans, non-human beings, and the environment.
- Apply philosophical concepts and ethical theories to real-world environmental issues and critically assess arguments and policy decisions.
- Demonstrate ethical conduct in scientific and environmental decision-making, recognizing moral obligations and the value of all life forms and ecosystems.

Full Marks- 35 (End term Examination- 30 and Internal Assessment- 5)
*Pattern of setting questions: **Group- A** (Long Answer Type): **TWO** questions, each of **10 marks** (without division), will be set for answering any **ONE**. **Group- B** (Semi-long Answer Type):**SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course content:

1. Geography as a science of synthesis. Changing nature of Geography: paradigm shift. Quantitative revolution and development of critical social theories: Humanistic geography, Radicalism and Feminist geography
2. Spatial and Temporal dimensions: Space - relevance in geography; temporal geography Structuralism and Post-structuralism, Modernism and Postmodernism
3. Applied Geography. Scope and opportunities under modern technology
4. Environmental Ethics, Education, and Philosophy: Concept and development of environmental philosophy,Ecocentrism vs. Anthropocentrism, Land Ethic (Aldo Leopold), Gaia Hypothesis, and Ecofeminism. Environmental education and global initiatives(Tbilisi conference). Conservation Approaches and stewardship : Landscape ecology and ethno-ecology, environmental stewardship.
5. Environmental Governance, Assessment, and Global Issues: Environmental Impact Assessment (EIA), Environmental Management Planning (EMP), Environmental Performance Assessment (EPA), Environmental Audit, Major international conferences,Achievements and Contradictions.

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

PAPER - GEOC451X8 (DSC 4):: SPATIAL ANALYSIS & MODELLING

Full Marks: 15 Credit: 1

Course outcome:

Full Marks- 15
*Pattern of Setting Questions: **Two** compulsory questions bearing **5** marks **each**, will be set covering the whole unit. **5 marks** will be allotted for Laboratory Note Book and Viva-voce.*

Course content:

1. Transport network analysis: Centrality Indices, Shortest path analysis (Transport and allocation problems), Detour and spread. Distance Matrix (Aggregate Travel Distance).
2. Point pattern analysis: Uniformity, randomness and compactness.
3. Analysis of directionality and shape: wind vector analysis; measures based on axial ratios, perimeters to areas, areas to axial length of the river basins.
4. Basic concept of spatial modelling; database creation, running ArcSWAT; model calibration and validation with SWAT-CUP
5. Morphometric analysis with ArcMAP and other open source packages.

PAPER - GEOC452X1 (DSC 5): HYDROLOGY & OCEANOGRAPHY

Full Marks:35 Credit: 3

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. Magnitude frequency of hydrological extreme events and their trends under the context of global climate change are included.
- Learners will be appraised on how different hydrological parameters interact as an interacting whole.
- Students will learn about the working principle of earth system processes that lead to hydrological hazards like drought and flood.

- The students will be able to understand the cyclic nature of ocean basins and land-ocean-atmosphere interactions leading to world climate change.
- An aptitude on the distribution of temperature and salinity of ocean waters and their role in oceanic circulations will be developed among the students.

- They will be informed about the marine environment and oceanographic processes that leads to earth system processes.

Full Marks- 35 (End term Examination- 30 and Internal Assessment- 5)
*Pattern of setting questions: **Group- A** (Long Answer Type): **TWO** questions, each of **10 marks** (without division), will be set for answering any **ONE**. **Group- B** (Semi-long Answer Type):**SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course content:

1. Hydrological systems, estimating water potential, and water budgeting at the watershed level. Hydrologic frequency analysis (Gumbel's equation and log probability law)
2. Estimating hydrological parameters: Precipitation estimates, runoff, infiltration and evapotranspiration.
3. Groundwater: storage structure, flow, recharge, and discharge. Flood and drought as hydrological hazards
4. The opening and closing of ocean basins (Wilson Model); Land-ocean-atmosphere interactions; Ocean Climate Zones
5. Temperature, and Salinity distribution; TS Diagram. Types and transport of ocean sediments.
6. Ocean Ecosystems: Coral Reefs; Rocky intertidal communities; Biology of coastal upwelling zones; Algal Blooms; Waste Disposal; National and International Law applied to the Oceans

PAPER - GEOC452X8 (DSC 5): HYDROLOGICAL TECHNIQUES

Full Marks: 15 Credit: 1

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 such as rainfall, run off, infiltration etc. in order to construct a 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- 15
*Pattern of Setting Questions: **Two** compulsory questions bearing **5** marks **each**, will be set covering the whole unit. **5 marks** will be allotted for Laboratory Note Book and Viva-voce.*

Course content:

1. Point rainfall analysis, area-depth curves, Thiessenpolygon and Isohyetal methods to determine rainfall depth. Time series analysis of precipitation; Mann-Kendall test, Sen's slope and change point analysis.
2. Estimating infiltration using infiltrometer 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.

PAPER - GEOE453A0 (DSE 3): REGIONAL PLANNING & DEVELOPMENT

Full Marks: 50 Credit: 4

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.
- 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- 50 (End term Examination- 40 and Internal Assessment-10)
*Pattern of setting questions: **Group- A** (Long Answer Type): **FOUR** questions, each of **10 marks** (without division), will be set for answering any **TWO**. **Group- B** (Semi-long Answer Type): **SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course content:

1. Concept and types of planning; planning regions in India: Purpose, types and methods of delineating planning regions,
2. Basic principles and methodology of regional planning.
3. Regional planning strategies: Centralized, decentralized and multilevel planning for rural and urban areas.
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.

6. Regional planning models: Growth Foci, Service Centre Approach, Rural-Urban Integration. NITI Aayog's strategies and Rurban Mission.

OR

PAPER - GEOE453B0 (DSE 3): (DSE 3) : SETTLEMENT GEOGRAPHY& TRANSPORT GEOGRAPHY

Full Marks: 50 Credit: 4

Course Outcome:

- The students will be able to understand the role of transport in overcoming distance barriers, including cost structures, comparative advantages of different transport modes, and the impact of communication technology on transport demand.
- The students will learn to analyze the significance of transport in economic and social processes, emphasizing locational advantages and the role of public transport in mitigating congestion and air pollution.
- Develop the ability to apply transport principles in regional development and economic regeneration through effective transport planning and sustainable mobility solutions.

Full Marks- 50 (End term Examination- 40 and Internal Assessment-10)
*Pattern of setting questions: **Group- A** (Long Answer Type): **FOUR** questions, each of **10 marks** (without division), will be set for answering any **TWO**. **Group- B** (Semi-long Answer Type): **SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course content:

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;
6. Communication Technology- roles in reducing transport demand.

PAPER - GEOE454A0 (DSE 4): RURAL DEVELOPMENT

Full Marks: 50 Credit: 4

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- 50 (End term Examination- 40 and Internal Assessment-10)
Pattern of setting questions: ***Group- A*** *(Long Answer Type):* ***FOUR*** *questions, each of* ***10 marks*** *(without division), will be set for answering any* ***TWO****.* ***Group- B*** *(Semi-long Answer Type):* ***SIX*** *questions, each of* ***4 marks*** *(without division), will be set for answering any* ***THREE****.* ***Group- C*** *(Short Answer Type):* ***EIGHT*** *questions, each of* ***2 marks*** *(without division), will be set for answering any* ***FOUR****.*

Course content:

1. Concept and indicators of Rural Development and their measurements.
2. Land Reform and agricultural development in India. Rural governance: Panchayet Raj System - structure and their functioning
3. Rural Economy and industrial development:Rural Micro-finance, self-help group and women empowerment. Rural Industries and entrepreneurship with special reference to Food Processing and Tourism.
4. Rural poverty alleviation programmes - National Rural Employment Guarantee Act, JawaharRozgarYojana, SampoornaGrameenRozgarYojana, Provisions of Urban Amenities in Rural Area (PURA);
5. Infrastructural development programmes - Pradhan Mantri Awas Yojna; Transport Development: PradhanMantri Gram SadakYojana
6. Political economy of the welfare programmes and developmental schemes.

OR

PAPER - GEOE454B0 (DSE 4): AGRICULTURAL GEOGRAPHY

Full Marks 50 Credits 04

Course outcome:

- This undergraduate course provides an in-depth exploration of agricultural geography, focusing on the spatial patterns, processes, and interactions between agriculture and the physical and human environments.
- This course gives special emphasis on the agro-ecological zones and green revolution in India. Students will examine key topics such as agricultural systems, land use, rural development, agro-social dynamics, food security and policies from a geographical perspective.
- By the end of this course, students will have a comprehensive understanding of the spatial aspects of agriculture, including the interactions between agriculture, environment, and society.
- To understand the role of green revolution in Indian agriculture.
- To learn critically analyzing agricultural systems and land use patterns, evaluate the environmental impacts of agriculture, and identify challenges and opportunities in agriculture, rural development, food security and policies in Indian context.

Full Marks- 50 (End term Examination- 40 and Internal Assessment-10)
Pattern of setting questions: ***Group- A*** *(Long Answer Type):* ***FOUR*** *questions, each of* ***10 marks*** *(without division), will be set for answering any* ***TWO****.* ***Group- B*** *(Semi-long Answer Type):* ***SIX*** *questions, each of* ***4 marks*** *(without division), will be set for answering any* ***THREE****.* ***Group- C*** *(Short Answer Type):* ***EIGHT*** *questions, each of* ***2 marks*** *(without division), will be set for answering any* ***FOUR****.*

Course content:

1. Agricultural Geography and Land Use: concepts and theories in agricultural geography.
2. Agro-climatic zones in India and significance, spatial patterns of agricultural systems and agricultural intensification, agricultural land use and landscape alteration.
3. Agriculture and Society: Role of agriculture and green revolution in India in rural development, farming systems and technologies (e.g., precision farming, genetic engineering, protein farm), agriculture and social structures in reference to caste and gender.
4. Agriculture, Environment and sustainability: Impacts of agriculture on natural resources (e.g., soil, water, biodiversity).
5. Climate change and its effects on agriculture, sustainable agricultural practices, Food security, Agricultural policies and institutions, their implications in India.
6. Agro-marketing and insurance: importance, prospects and challenges in India

PAPER - GEOE455A0 (DSE 5): SOCIAL & CULTURAL GEOGRAPHY

Full Marks: 50 Credit: 4

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- 50 (End term Examination- 40 and Internal Assessment-10)
*Pattern of setting questions: **Group- A** (Long Answer Type): **FOUR** questions, each of **10 marks** (without division), will be set for answering any **TWO**. **Group- B** (Semi-long Answer Type): **SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course content:

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.
6. Culture, Landscape, and Globalization:.Globalization, hybrid cultures, migration, and diasporic geographies.

OR

PAPER - GEOE455B0 (DSE 5): GENDER, SPACE AND CRIME

Full Marks 50 Credits 04

Course outcome:

- Gender violence is routine and spectacular, structural, symbolic as well as situated. It is rooted horizontally and vertically across space and social tradition.This course attempts to provide
- An understanding of the logic of gendered violence and its varied expressions across space in the historical and contemporary contexts.
- The course will provide awareness about the numerous institutionalized-legal struggles as well as everyday resistances against gender violence to equip the students for making pragmatic, ethical and effective choices while resisting or intervening in the context of gendered violence.

- Analyze how the social construction of gender across cultures is fundamental to several experiences of violence.
- Engage with different theoretical perspectives and their critiques in the comprehending-individual, social, cultural, political, or economic experiences of violence.
- Spatial pattern of crime across varied physical and socio-economic setup.

Full Marks- 50 (End term Examination- 40 and Internal Assessment-10)
*Pattern of setting questions: **Group- A** (Long Answer Type): **FOUR** questions, each of **10 marks** (without division), will be set for answering any **TWO**. **Group- B** (Semi-long Answer Type): **SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course Content:

1. Conceptual Frameworks for understanding Gender
2. Space place and crime;Deconstructing Gender and Gendered Violence
3. spatial dimensions of Gender-based violence : South East Asia,India and West Bengal
4. Space specificity of Crime: Crime in Urban areas, Environmental hazard zones, Socio Economically backward areas ,International and National Border Zones
5. Laws against violence & Sexual crimes: eve teasing, rape, indecent representation of women, abduction and kidnapping, immoral trafficking, domestic violence.
6. Legal frameworks and policies related to gendered crimes (India and global);Role of police, judiciary, NGOs, and civil society.

PAPER - GEOC456X9 (SEC 1): Field Visit/ Industry Visit/Case Study/ Hands-on Practical/ Skill Enhancement Course:

ECOLOGICAL CENSUS TECHNIQUES

Full Marks 25 **Credit 2**

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.*

Course content:

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

SEMESTER- III (275 Marks)

PAPER- GEOC502X1 (DSC 6): METEOROLOGY & CLIMATOLOGY

Full Marks 35 Credit 3

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

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

Full Marks- 35 (End term Examination- 30 and Internal Assessment- 5)
*Pattern of setting questions: **Group- A** (Long Answer Type): **TWO** questions, each of **10 marks** (without division), will be set for answering any **ONE**. **Group- B** (Semi-long Answer Type):**SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course Content:

1. 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.
2. Meteorological and climatological systems in different space-time scales: thunderstorms, tropical cyclones, jet streams, and planetary wind systems.
3. Basics of climate modelling: one-dimensional climate model, role of greenhouse gas and aerosols in climate.
4. 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.
5. The mechanism of Indian summer monsoon: implication of elevated heat pump (EHP) theory in monsoon precipitation, MONEX, hydro-climatic teleconnections: Pacific Decadal Oscillation, North Atlantic Oscillation, ENSO.
6. Physical basis of global climate change; IPCC Assessment Reports - plausible future climate change scenarios with respect to shared socio-economic pathways (SSP).

PAPER - GEOC502X8 (DSC 6): CLIMATE CHANGE ASSESSMENT TECHNIQUES

Full Marks 15 Credit 1

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.

Full Marks- 15
*Pattern of Setting Questions: **Two** compulsory questions bearing **5** marks **each**, will be set covering the whole unit. **5 marks** will be allotted for Laboratory Note Book and Viva-voce.*

Course Content:

1. Global and regional temperature change; correlate CO2 data with temperature; Data sources, download, processing and presentation.
2. Climatological anomalies: multiscale temperature and precipitation anomalies (annual, seasonal and monthly scale).
3. Analysis of CMIP6 temperature and precipitation data based on SSP scenarios.
4. Analysis of hydro-climatic teleconnction through SST and precipitation data.
5. Data visualization: building publication quality graphs and plots (time series plot, boxplots, uncertainty bands, stack plots) with climate data using open source software; presentation of the data.

PAPER - GEOE503A0/B0/C0/D0/E0 (DSE 6) DEPARTMENT SPECIFIC ELECTIVES (**SPECIAL PAPERS)**

PAPER - GEOE503A0 (DSE 6): PROCESS GEOMORPHOLOGY

Full Marks: 50 Credit: 4

Course Outcome:

- Students will learn about the mechanism and working principle of geomorphic processes in detail that lead to shape the present earth-surface, especially the thresholded nature of process-form relationship.
- This course will foster knowledge on Quaternary environmental change and landform development with special reference to glaciations and sea level change
- They will also have a clear insight into the process and forms on the surface of Moon and Mars.
- This course aims to build an understanding role of humans in shaping earth surface and regulating natural processes and their outcome on natural systems.

- This understanding may help in formulating a plan for management of land, water and soil, three basic resources on earth surface. Learners may take part in sustainable resource management.

Full Marks- 50 (End term Examination- 40 and Internal Assessment-10)
*Pattern of setting questions: **Group- A** (Long Answer Type): **FOUR** questions, each of **10 marks** (without division), will be set for answering any **TWO**. **Group- B** (Semi-long Answer Type): **SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course Content:

1. Geomorphic Thresholds: Reynold Number, Froude Number, Critical shear Stress and Shield Diagram, Slope stability thresholds.
2. 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.
3. Relevance of coastal study. Coastal Processes and Forms. Quaternary Environmental Change and Landform Development with special reference to glaciations and sea level change.
4. Planetary geomorphic processes and landforms: Moon and Mars.
5. Anthropogeomorphology: Man as active geomorphic agent. Landuse change and its geomorphic implications.
6. Identification of Geomorphosites with special reference to India.

PAPER - GEOE503B0 (DSE 6): SUSTAINABLE URBAN DEVELOPMENT AND PLANNING-I

Full Marks: 50 Credit: 4

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
- 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- 50 (End term Examination- 40 and Internal Assessment-10)

*Pattern of setting questions: **Group- A** (Long Answer Type): **FOUR** questions, each of **10 marks** (without division), will be set for answering any **TWO**. **Group- B** (Semi-long Answer Type): **SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course Content:

1. Development of urban geography, Urban places, Urbanisation pattern in the World and India, urbanism, urban ecology, and national urban system.
2. Changing spatial and temporal scenario of metropolitan development in India, Structure of urban economy-basic and non-basic activities.Contemporary urban forms: suburbs, exurbs,: suburban sprawl, ghettos, gentrification.
3. Concept of Sustainability in Urban Contexts: definition, objectives, and dimensions of urban sustainability, Sustainable Development Goals (SDG 11) and the New Urban Agenda.
4. Indicators and Metrics for Sustainable Urban Development.
5. Urban Ecosystems and the role of green infrastructure: Urban Green Space, Green cities, Livability Index, Ecological Footprint.
6. Governance and Institutional Frameworks in Urban Sustainability: policies, institutional frameworks, and governance challenges. Sustainable urbanism.

PAPER - GEOE503C0 (DSE 6): BASICS OF REMOTE SENSING AND PHOTOGRAMMETRY

Full Marks: 50 Credit: 4

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- 50 (End term Examination- 40 and Internal Assessment-10)
*Pattern of setting questions: **Group- A** (Long Answer Type): **FOUR** questions, each of **10 marks** (without division), will be set for answering any **TWO**. **Group- B** (Semi-long Answer Type): **SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course Content:

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. Fundamental of Thermal Remote Sensing: Radiant temperature, Kinetic temperature, Black body and real body radiation.
2. Satellite orbits and Trajectories: Principles of satellite movements, orbits and trajectory, orbiting satellites-basic principles, orbital parameters, types of satellites. Satellite platforms and sensor

types; Concept of IFOV, resolution and determination of pixel size, referencing scheme of satellite system (path/row calculation). Remote sensing data: data type, storage and dissemination.

3. Active and passive remote sensing systems, multispectral remote sensing; DN to radiance and reflectance conversion, Principles atmospheric correction. Analysis of spectral signatures: spectral distance mapping for object identification from remotely sensed data.
4. Basics of Aerial Photograph: Types of aerial photographs, Geometry of single Aerial Photograph, Photographic overlap, flight planning, Scale, Lens Distortions, determination of scale and heights; Relief distortions and Tilt distortions. Image displacement and parallax.
5. Aerial Photographic Film: Film density and Characteristics Curve, Colour Infrared Films, Film resolution, Filters.
6. Stereo photogrammetry: Conditions for Stereo vision, stereoscopic measurements, Sterescopic 3D viewing, Image parallax, Rectification, Orthorectification; Air photo interpretation keys: shape, size, pattern, tone, texture, shadow, site and associations

PAPER - GEOE503D0 (DSE 6): THEORIES IN LANDSCAPE ECOLOGY

Full Marks: 50 Credit: 4

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.
- 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- 50 (End term Examination- 40 and Internal Assessment-10)
*Pattern of setting questions: **Group- A** (Long Answer Type): **FOUR** questions, each of **10 marks** (without division), will be set for answering any **TWO**. **Group- B** (Semi-long Answer Type): **SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course Content:

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 Ecology, Metrics and Models: Metrics and models for quantifying landscape structure and estimation of landscape ecological quality.Neutral Models in Landscape Ecology
6. Landscape conservation: a new paradigm for the conservation of biodiversity

GEO - GEOE503E0 (DSE 6): CLIMATE SCIENCE & MODELLING

Full Marks: 50 Credit: 4

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,

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

Full Marks- 50 (End term Examination- 40 and Internal Assessment-10)
*Pattern of setting questions: **Group- A** (Long Answer Type): **FOUR** questions, each of **10 marks** (without division), will be set for answering any **TWO**. **Group- B** (Semi-long Answer Type): **SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course Content:

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. Radiative transfer model for energy transmission in the surface-atmospheric system. Cloud physics: radiation-cloud interaction, cloud microphysics and its alteration
3. Atmospheric aerosols: sources, distribution and chemistry of aerosols; effect on weather and climate; radiative forcing study, estimation of green house effect.
4. Overview of global climate models and climate modelling; radiation and precipitation schemes; RCP/ SSP scenarios and their implication as reported in IPCC AR6.
5. Climatology 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.
6. ISMR anomalies and their connection with large scale coupled oceanic-atmospheric circulation; AR/MA and ARIMA processes for time series forecasting of climate variables; the implication of EOF in climate study; Bias correction and downscaling of GCM data.

PAPER - GEOC504X9 (DSC 7): STATISTICS AND CARTOGRAPHIC TECHNIQUES

Full Marks: 50 Credit: 4

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.
- 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- 50
*Pattern of Setting Questions: **Four** compulsory questions bearing **10** marks **each**, will be set covering the whole unit. **10 marks** will be allotted for Laboratory Note Book and Viva-voce.*

Course Content:

1. Idea of random sampling; deciding sample size; Probability distribution: concept of probability distributions (binomial distributions, normal probability distribution), properties of normal curve. Use of normal curve; hypothesis testing: formulation of acceptance/rejection rule, significance level, degrees of freedom, type I and type II errors; one and two tailed tests: t-test, z-test and Chi-square tests; examples with open source packages.
2. Measurement in Geography: Nominal, ordinal, interval and ratio measurement. Concept of covariance, correlation: Product moment correlation, Spearman's Rank correlation, correlation matrix, oneway and two way ANOVA.
3. Fundamentals of bi-variate linear regression: assumptions, problem of estimation, problem of inference, model's explanation and error analysis through F-score and information criterion.
4. Basics of multivariate linear model: problem of estimation, multicollinearity effect, model building techniques and selection process through ANOVA. Fundamentals of principal component analysis, Application of open source package in statistical analysis.
5. Mathematical basics of map projection, construction of conical projection with two standard parallel, Mercator's projection, Lambert conformal conical projection
6. Basics of GPS Surveying: Conceptual Framework, Space Segment, Ground Segment, Control Segment, Satellite Triangulation, Pseudo Random Code. Fundamental principles DGPS, global navigation systems, Implication of locational and spatial attributes in GIS and remote sensing.

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

PAPER - GEOE505X9 (DSE 7): SPECIAL PAPER BASED FIELDWORK/ INTERNSHIP

Full Marks: 50 Credit: 4

FIELD WORK (AS PER SPECIAL PAPER)

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.

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.

Field work and Report Preparation -25 (Examined by Internal Examiner); Presentation of research work-25 (Grand Viva-10 and/or Power Point presentation-15) (Examined by External Examiner)

PAPER - GEOC501X0 (MOOCs): MOOC COURSE

Full Marks: 50 Credit: 4

Course to be selected from Swayam Portal

PAPER - GEOC506X9 (SEC 2): SOCIAL SERVICE AND COMMUNITY ENGAGEMENT

Full Marks: 25 Credit: 2

Course Outcome:

This course aims to integrate geographical knowledge with social service and community engagement practices. After completing this course:

- Students will understand the role of geographers in addressing social issues through community participation, sustainable development, and grassroots involvement.
- Students will develop skills in fieldwork, project management, and community-based research to contribute effectively to society.
- Design and implement community-oriented projects to address socio-spatial issues.
- Develop critical skills for participatory research and inclusive development.
- Appreciate the role of geography in policy-making, planning, and sustainable community development.

Field work and Report Preparation -15 (Examined by Internal Examiner); Presentation of project work-10 (Viva-05 and Power Point presentation-05; Examined by External Examiner)

Course content:

1. Philosophical perspectives and scope of social service and community engagement in geography.
2. Role of geographers in social service. Ethical considerations in working with communities
3. Sustainable development and inclusive growth, Community needs assessment and social diagnostics
4. Organizing and facilitating community meetings and focus groups, Identifying community issues and resources, Designing intervention strategies for social upliftment
5. Case studies of successful geography-led community initiatives

SEMESTER-IV (275 Marks)

PAPER – GEOC551X1 (DSC 8): ENVIRONMENTAL ENGINEERING AND ENERGY, WATER AND FOOD NEXUS

Full Marks: 50 Credit: 4

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.
- 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- 35 (End term Examination- 30 and Internal Assessment- 5)
*Pattern of setting questions: **Group- A** (Long Answer Type): **TWO** questions, each of **10 marks** (without division), will be set for answering any **ONE**. **Group- B** (Semi-long Answer Type):**SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course content:

1. Definition and domain of Environmental Engineering, Waste water treatment: Primary, Secondary and Tertiary treatment. .Solid (Municipal) waste management; Hazardous waste management.
2. Air sampling and analysis process for studying inorganic chemistry of the atmosphere, Inorganic chemistry of rainwater with its source attribution: spectroscopic principle; air pollution control technologies. Indoor air pollution. Noise Pollution: Measurement of noise, Biophysical impacts, Mitigation technologies.
3. Environment Restoration: Principles, Planning and Techniques
4. Concept: Understanding water-energy-food nexus (WEF) Policies, 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

5. Energy production and consumption: Renewable and non-renewable energy resources: Emerging challenges and opportunities
6. Food production: Green revolution and farm mechanisation in the light of WEF nexus, Food security: Ensuring food security through managing WEF nexus

PAPER – GEOC551X8 (DSC 8): ENVIRONMENTAL MONITORING AND ASSESSMENT

Full Marks: 15 Credit: 1

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- 15
*Pattern of Setting Questions: **Two** compulsory questions bearing **5** marks **each**, will be set covering the whole unit. **5 marks** will be allotted for Laboratory Note Book and Viva-voce.*

Course content:

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), NO2 and SO2 by colorimetric/spectroscopic method(s).
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.

PAPER – GEOE552A0/B0/C0/D0/E0 (DSE 8): DISCIPLINE SPECIFIC ELECTIVE (SPECIAL PAPER)

PAPER – GEOE552A0 (DSE 8): ADVANCED GEOMORPHIC TECHNIQUES

Full Marks: 50 Credit: 4

Course Outcome:

- Students will learn about the methods to estimate various geomorphic attributes by using field instruments or through models run by sophisticated software.
- 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.
- This will offer them training on data generation, computation and analysis. This course aims to enable learners to deal with real world problems using advanced technology.
- 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 will revive the applied value of the discipline and foster applied aptitude among the students.

Full Marks- 50 (End term Examination- 40 and Internal Assessment-10)
Pattern of setting questions: ***Group- A*** *(Long Answer Type):* ***FOUR*** *questions, each of* ***10 marks*** *(without division), will be set for answering any* ***TWO****.* ***Group- B*** *(Semi-long Answer Type):* ***SIX*** *questions, each of* ***4 marks*** *(without division), will be set for answering any* ***THREE****.* ***Group- C*** *(Short Answer Type):* ***EIGHT*** *questions, each of* ***2 marks*** *(without division), will be set for answering any* ***FOUR****.*

Course content:

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. Manning equation: Required data, data measurements, and limitations;
3. Tractive force and stream power estimation.Sediment transport and sediment discharge estimates: Bed load and suspended load.
4. Applied Geomorphology in River Basin Management. Geomorphology in dam site selection and impact assessment.
5. Applied Geomorphology in Hazard Management: flood, river bank erosion. Geomorphology in urban management: Landuse planning, sewage treatment, storm-water management.
6. Coastal Hazards: cyclone, bank erosion and saline flood. Geomorphology in EIA and EMP.

PAPER - GEOE552B0 (DSE 8): SUSTAINABLE URBAN DEVELOPMENT AND PLANNING-II

Full Marks: 50 Credit: 4

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.
- 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.
- 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- 50 (End term Examination- 40 and Internal Assessment-10)
Pattern of setting questions: ***Group- A*** *(Long Answer Type):* ***FOUR*** *questions, each of* ***10 marks*** *(without division), will be set for answering any* ***TWO****.* ***Group- B*** *(Semi-long Answer Type):* ***SIX*** *questions, each of* ***4 marks*** *(without division), will be set for answering any* ***THREE****.* ***Group- C*** *(Short Answer Type):* ***EIGHT*** *questions, each of* ***2 marks*** *(without division), will be set for answering any* ***FOUR****.*

Course content:

1. Concepts and Frameworks of Urban Planning – principles of urban growth; balanced vs. unbalanced growth; intra- and inter-regional planning; policies and strategies for sustainable urban development.
2. Theories and Approaches to Sustainable Urban Planning – compact city model, smart growth, eco-city framework.
3. Urban Land Use planning – zoning, master plans, global frameworks including UN-Habitat initiatives.
4. Resilience and Climate-Smart Urbanism – conceptual foundations of resilient cities; climate-sensitive planning, risk assessment, and urban adaptation strategies.
5. Urban Infrastructure and Environmental Sustainability – integrated systems of sanitation, water supply, waste water treatment, and solid waste management; sustainable resource use and green infrastructure.

6. Sustainable Infrastructure and Services – transit-oriented development (TOD), sustainable transportation and mobility systems; inclusive housing policies, slum rehabilitation, and planning for the urban poor.

PAPER – GEOE552C0 (DSE 8): APPLIED REMOTE SENSING AND GIS

Full Marks: 50 Credit: 4

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- 50 (End term Examination- 40 and Internal Assessment-10)
Pattern of setting questions: ***Group- A*** *(Long Answer Type):* ***FOUR*** *questions, each of* ***10 marks*** *(without division), will be set for answering any* ***TWO****.* ***Group- B*** *(Semi-long Answer Type):* ***SIX*** *questions, each of* ***4 marks*** *(without division), will be set for answering any* ***THREE****.* ***Group- C*** *(Short Answer Type):* ***EIGHT*** *questions, each of* ***2 marks*** *(without division), will be set for answering any* ***FOUR****.*

Course content:

1. Microwave Remote Sensing: Concept, advantages and disadvantages, spatial resolution, Real and Synthetic Aperture Radar, Passive Microwave Remote Sensing, Lidar, Radar interferometry, Differential interferometry, Polarimetry, and SRTM
2. Hyperspectral remote sensing: concept, sensors, reflectance spectra, spectral library. Digital image pre-processing: contrasts stretching for image enhancement, image transformation through PCA, image classification, generation of image statistics using image processing package.
3. Concept of spatial data model: raster and vector data models, mathematical and logical operations using raster and vector data in GIS/image processing package. Digital Elevation Model: DSM, DTM; Calculation of Slope and Aspect for watershed analysis.
4. Remote sensing of vegetation; satellite-based applications for mapping vegetation, including agricultural land, vegetation health, and leaf water content assessment.
5. Remote sensing of soil and water; soil moisture estimation, estimation of suspended sediment load in the river and coastal waters.
6. Remote sensing of the atmosphere; retrieval of precipitation from satellite data, retrieval of cloud and aerosol optical depth from optical images.

PAPER – GEOE552D0 (DSE 8): SPATIAL ANALYSIS IN LANDSCAPE ECOLOGICAL DYNAMICS

Full Marks: 50 Credit: 4

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.
- 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- 50 (End term Examination- 40 and Internal Assessment-10)
Pattern of setting questions: ***Group- A*** *(Long Answer Type):* ***FOUR*** *questions, each of* ***10 marks*** *(without division), will be set for answering any* ***TWO****.* ***Group- B*** *(Semi-long Answer Type):* ***SIX*** *questions, each of* ***4 marks*** *(without division), will be set for answering any* ***THREE****.* ***Group- C*** *(Short Answer Type):* ***EIGHT*** *questions, each of* ***2 marks*** *(without division), will be set for answering any* ***FOUR****.*

Course content:

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; 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.
5. 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.
6. Application of GIS techniques for landscape modeling : ArcGIS tools for connectivity and corridor modelling, habitat modelling Computation of landscape metrics using FRAGSTATS

PAPER – GEOE552E0 (DSE 8): APPLIED HYDRO-CLIMATOLOGY

Full Marks: 25 Credit: 2

Course Outcome:

This curse is designed to produce a deeper understanding of fundamentals of the 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,

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

Full Marks- 50 (End term Examination- 40 and Internal Assessment-10)
*Pattern of setting questions: **Group- A** (Long Answer Type): **FOUR** questions, each of **10 marks** (without division), will be set for answering any **TWO**. **Group- B** (Semi-long Answer Type): **SIX** questions, each of **4 marks** (without division), will be set for answering any **THREE**. **Group- C** (Short Answer Type): **EIGHT** questions, each of **2 marks** (without division), will be set for answering any **FOUR**.*

Course content:

1. Atmospheric water; Changing water cycle: global and regional constraints of water cycle, observed changes of water cycle based on multiple dataset. Extreme weather events: causes and measurements.
2. Estimation of PBLH through radiosonde data; other data sources of PBLH; the implication of PBLH in weather and climate studies. Fundamentals of HYSPLIT trajectory modelling, Data sources of air mass trajectory, Trajectory analysis: potential source contribution function (PSCF) and clustering
3. Distort Atmospheric Radiative Transfer (DART) and Optical Properties of Aerosols and Cloud (OPAC) models for studying atmosphere and radiation interaction
4. Global and regional scale weather and climate data sources: ECMWF, CRU, NCAR, APHRODITE, IMD-gridded products. Estimation of climatology, anomaly and trend of these data sets using open source packages.
5. Studying clouds using satellite and reanalysis data; cloud fraction, cloud height, cloud top pressure and temperature and cloud effective radii
6. Studying global and regional scale aerosol loading using satellite-derived products with the help of CDO, R, Python languages; aerosol-cloud-precipitation interaction with statistical models.

PAPER – GEOC553X9 (DSC 9): APPLICATION OF GEOLOGICAL & GEOMORPHIC MAPPING AND RS-GIS

Full Marks: 50 Credit: 4

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 benefit from rigorous practice and comprehensive theories.
- 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

Course content:

1. Identification of geologic structures; drawing section of the given Geological Map (Unconformity, fold, fault, intrusion) and interpretation
2. Identification of Rocks and Minerals
3. Interpretation of physical and cultural landscapes from the SOI Toposheet
4. Digital image processing: histogram equalization, linear contrast stretching, image reduction
5. Image classification: supervised and unsupervised classification schemes, classification accuracy; Georeferencing, creating spatial database and thematic mapping

PAPER – GEOC554X9 (DSC 10): RESEARCH PROJECT/ DISSERTATION

Full Marks: 100 Credit: 8

Data Collection, analysis and Report Preparation -50 (Examined by Internal Examiner); Adjudication of the work and Presentation 50 (Viva-25 and Power Point presentation-25) (Examined by External Examiner)

1. Problem Selection and Methods of Study
2. Field Investigation and Database generation
3. Data analysis and Report Writing
4. Presentation and Viva-Voce

PAPER - GEOC555X9 (SEC 4): INTELLECTUAL PROPERTY RIGHT (IPR)/SKILL ENHANCED COURSE

APPLICATION OF AI/ML IN GEOGRAPHY

Full Marks: 25 Credit: 2

Course outcome:

upon completion of this course, students will be able to

- gain a theoretical knowledge of how AI/ML work in data space
- learn when to use AI/ML in the analysis
- learn how to prepare the data for an effective AI/ML model
- perform the model's uncertainty analysis and select the best predictive model for a given data

Course content

1. Theoretical basics of machine learning (ML), a data driven approach; ML methods: classification and regression tree, random forest, gradient boosting, support vector machine, k-nearest neighbor.
2. Fundamentals of artificial intelligence (AI); mathematical basics of artificial neural networks and deep learning.
3. Data preparation; partitioning for training and testing; cross validation; model uncertainty: deterministic error metrics - mean square error, mean absolute error, root mean square error, NSC; probabilistic error metric - rank probability score
4. Application of AI/ML techniques with open source packages.
5. Case study and preparing report using AI/ML tool.

OR

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

Full Marks 25 Credit 2

Course outcome:

Upon completion, students will be able to:

- Understand the theoretical and legislative basis of EIA
- Apply appropriate methodologies for impact assessment across sectors
- Critically evaluate EIA reports and engage in project appraisal
- Integrate modern tools like GIS in impact assessment
- Promote informed decision-making in development planning

Course Content:

1. Foundations and Theoretical Framework of EIA:Concept, need, and objectives of EIA, Principles of sustainable development and EIA
2. Methodologies and Tools for EIA: Screening, scoping, baseline data collection, prediction, evaluation.
3. Impact identification and quantification: Air, water, soil, noise, biodiversity. GIS and remote sensing in EIA
4. EIA report: Checklists, matrices, overlays.
5. Case study on developmental projects

Suggested Reading

SEMESTER-I (275 Marks)

PAPER - GEOC401X1 (DSC 1): FOUNDATIONS IN BIOGEOGRAPHY AND ENVIRONMENTAL SUSTAINABILITY:

- Briggs, J. C. (1995). Global biogeography. Elsevier.
- Cox, C. B., Moore, P. D., & Ladle, R. J. (2016). Biogeography: an ecological and evolutionary approach. John Wiley & Sons.
- Dansereau, P. (1957). Biogeography. An ecological perspective. Biogeography. An ecological perspective
- Hengeveld, R. (1992). Dynamic biogeography. Cambridge University Press.
- Hominick, W. M. (2002). Biogeography. Entomopathogenic nematology, 1, 115-143.
- Whittaker, R. J., Araújo, M. B., Jepson, P., Ladle, R. J., Watson, J. E., & Willis, K. J. (2005). Conservation biogeography: assessment and prospect. Diversity and distributions, 11(1), 3-23.

PAPER - GEOC402X8 (DSC 1): THEMATIC MAPPING

- Basu, R. and Bhaduri, S. (2007): Contemporary Issues and Techniques in Geography, Progressive Pub.
- Dent., D.B (1993): Cartography: Thematic map design, Sea Brown Publishers
- Misra, R.P and Ramesh, A (1989): Fundamental of Cartography, Concept, Delhi
- Monkhouse F.J. and Wilkinson, H.R. (1971): Maps and Diagrams: Their Compilation and Construction, B.I. Publications Private Limited, New Delhi: 527p.
- Nag, P and Dutta, G.K (1992): Thematic Cartography and Remote Sensing, Concept
- Wilford, J,N (2000): The Map Makers, A.A. Knopf

PAPER - GEOE402A0 (DSE 1): POPULATION GEOGRAPHY & GLOBAL ECONOMIC CRISIS, GEOPOLITICS

POPULATION GEOGRAPHY:

- Binde and Kanitkar (2000): The Principle of Population Studies, Himalaya Publication
- Chandna, R.C. (2015): Geography of Population, Rawat, New Delhi.

- Dyson, T. (2010): Population and Development, Rawat publication, Jaipur
- Gould, W. T. S. (2009): Population and Development (Series - Routledge Perspectives on Development); Taylor & Francis.
- Hassan, Mohammad. Izhar, (2015): Population Geography, Rawat publication, Jaipur
- Majumdar, P.K (2010): Fundamentals of Demography, Rawat publication, Jaipur
- Morris, A (1998):Geography and Development, University College London Press, London
- Mourya S.D. (2017): Population Geography, Pravalika Publications, Allahabad
- Muhammad I.H. (2007): Population Geography, Rawat publication, Jaipur
- Mukherji, S. (2013): Migration in India, Rawat publication, Jaipur
- Nag, Prithvish; Kumar, Chandra Shekhar and Sengupta, Smita. (2001): Environment, Population and Development; Concept Publishing Company.
- Newbold K. Bruce (2017): Population Geography: tools and issues, Rawat publication
- Premi, M.K.(2006): Demography and its exposition, Jwahar Publication, New Delhi
- Srivastava, A. K. (2004): Population Development, Environment and Health; Aph Publishing Corporations.
- Sroaff, Meera. (2004): Population and Sustainable Development; Adhyayan Publishers and Distributors.

GLOBAL ECONOMIC CRISIS, GEOPOLITICS:

- Appaduria, A. (2001): Globalization, Duke University Press
- Cofman, E and Youngs, G (1996): Globalization: Theory and Practice, Continum International PublishingGroup.
- Dasgupta, Biplab (2005): Globalization- India's Adjustment Experience; SAGE, New Delhi.
- Goldin, I and Reinert, K (2012) : Globalization for Development, Oxford University Press, New York
- Haggett, P. (2001): Geography: A Global synthesis, Prentice Hall
- Kumar, Y. (2021). GEOPOLITICS IN THE ERA OF GLOBALISATION. Routledge.2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN.
- Mackinnon, D. and Cumbess, A. (2007): An Introduction to Economic Geography: Globalization, Unevendevelopment and ……, Prentice Hall
- Mc Cann(Eds)(2004):From Local to the Global, Rawat PublishersTomlinson, J (1999): Globalization and Culture, Cambridge Polity presss

- Potter, R.B and Binns, Tony (Eds) (2001); Globalization and Development, Pearson Education Limited,Harlow
- Vertova, G. (2006): The changing economic geography of Globalization, Routledge
- W.Murray (2006): Geographies of Development, Routhledge Publication
- Youngs, G. (2001): Globalization, Communication and Technology, Cambridge.

PAPER - GEOE402B0 (DSE 1): LANDSCAPE ECOLOGY AND PLANNING

- Farina, Almo:Principles and Methods in Landscape Ecology Towards a Science of the LandscapeSeries: Landscape Series, Vol. 3,Springer
- Forman R.T.T.: Land mosaic. The ecology of landscape and region. Academic press Cambridge UK
- Frohn Robert C. (1997): Remote Sensing for Landscape Ecology: New Metric Indicators for Monitoring,Modeling, and Assessment of Ecosystems, Taylor & Francis
- GadgilMadhav , Guha Ramachandra : The Use and Abuse of Nature: incorporating This Fissured Land:An Ecological History of India and Ecology and Equity, Oxford University Press.
- Hutchinson and Smith, D. (1996) : Ethnicity : Oxford University Press, Delhi
- Jones, Emrys (1965): Human Geography, Chatto and Windies, London. Jones, E. and Eyles, J. (1977): AnIntroduction to Social Geography, Oxford University Press, Oxford
- Jordon and Lester, G. (1995) : The Human Mosaic, Harper and Row, New York
- Knoy, P. L. (1988) : Social Well-being – A Spatial Perspective, Oxford University Press, London
- Rubenstain, J. M. and Becon, J. M. (1990): Cultural Geography, John Wiley and Sons Inc., New York.
- Spencer, J. E. and Thomas, W. L. (1969): Cultural Geography, John Wileyand Sons Inc., New York.
- Turner M.G. & Gardner R.H .: Quantitative method in landscape ecology Springer-Verlag New York
- Turner M.G. :Landscape Heterogeneity and disturbanceSpringer-Verlag , Germany
- Turner, Monica G., Gardner, Robert H., O'Neill, Robert V.:Landscape Ecology in Theory and PracticePattern and Process,Springer
- Vink A.P.A.: Landscape ecology and land use, Longman, London & New York
- Wu jianguo and Hobbs Richard j. (2007): Key Topics in Landscape Ecology, Cambridge University Press

PAPER - GEOC403X1 (DSC 2): RESEARCH METHODOLOGY AND ETHICS

- Alvi. Z. (1995): Statistical Geography: Methods and Applications, Rawat Publication, New Delhi
- Compton,R.R.(1985): Geology in the Field, John Wiley and Sons.
- Gardiner,V. and Dacombe,R.(1983):Geomorphological Field Mannual,George Allen and Unwin, London
- Ghosh,B.N.(1982): Scientific Methods and Social Research ,Starling Publishers Private Ltd. New Delhi.
- Goudie, A. (1981): Geomorphological Techniques, George Allen and Unwin, London
- John, C. D. (2002): Statistics and Data Analysis in Geology; John Wiley & Sons.
- Kothari,R.C(2004):Research Methodology,New Age International Publishers, New Delhi.
- Mahmood, A (1977): Statistical methods in Geographical studies, Rajesh Pub. New Delhi
- Mishra,H.N(1998): Research Methodology in Geography,Rawat Publication.
- 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, New Delhi
- Shama,B.A.V. et al (1983): Research Methods in Social Sciences, Chaitanya Publishing House, Allahabad.
- Sjoberg g. and Nett (2002): Methodology of Social Research, Rawat Publication
- Wang, X and Vonhofe, R.a (2007): Research Method in Urban and Regional Planning, Springer
- Young,P.V.(1960): Scientific Social Surveys and Research 3rd Ed ,Prentice Hall, New York.

PAPER - GEOC403X8 (DSC 2): RESEARCH METHODOLOGY AND ETHICS

- Alvi. Z. (1995): Statistical Geography: Methods and Applications, Rawat Publication, New Delhi
- Compton,R.R.(1985): Geology in the Field, John Wiley and Sons.
- Gardiner,V. and Dacombe,R.(1983):Geomorphological Field Mannual,George Allen and Unwin, London
- Ghosh,B.N.(1982): Scientific Methods and Social Research ,Starling Publishers Private Ltd. New Delhi.
- Goudie, A. (1981): Geomorphological Techniques, George Allen and Unwin, London
- John, C. D. (2002): Statistics and Data Analysis in Geology; John Wiley & Sons.
- Kothari,R.C(2004):Research Methodology,New Age International Publishers, New Delhi.

- Mahmood, A (1977): Statistical methods in Geographical studies, Rajesh Pub. New Delhi
- Mishra,H.N(1998): Research Methodology in Geography,Rawat Publication.
- 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, New Delhi
- Shama,B.A.V. et al (1983): Research Methods in Social Sciences, Chaitanya Publishing House, Allahabad.
- Sjoberg g. and Nett (2002): Methodology of Social Research, Rawat Publication
- Wang, X and Vonhofe, R.a (2007): Research Method in Urban and Regional Planning, Springer
- Young,P.V.(1960): Scientific Social Surveys and Research 3rd Ed ,Prentice Hall, New York.

PAPER - GEOE404A0 (DSE 2): REGIONAL GEOMORPHOLOGY OF INDIA & WEST BENGAL

- Ahmad, Enayat. (1972): Coastal geomorphology of India; Orient Longman.
- Biswas, A. (1987): Laterites and lateritoids, Explorations in the tropics: V.S. Datyeet. al., Prof.K.R.Dikshit felicitation Committee, Pune, PP.137-140.
- Mukhopadhyay, S.C: Geomorphology Of The Subarnarekha Basin: The Chota Nagpur Plateau (easternIndia, the University of Burdwan,
- Rawat, T. (2008): Environment of the Himalayas, Eastern Book Corporation
- Sehgal, J and Blum, W.E et al. (1998): Red and Lateritic Soils, Oxford and IBH pub.
- Sharma, H. S. (1991): Indian Geomorphology, Concept Publishing Company. Starkel, L. and Basu, S. 2000 Rains, Landslides and Floods in the Darjeeling Himalaya, Indian NationalScience academy, New Delhi: 168p
- Sharma, HariShanker. (1982): Perspectives in Geomorphology; Concept.

PAPER - GEOE404B0 (DSE 2): WATER RESOURCES MANAGEMENT

- Bogardi, J. J., Aureli, A., & Bogardi, J. F. M. (Eds.). (2021). Integrated Water Resources Management: Concepts, Research, and Implementation. Springer.
- Cech, T. V. (2016). Principles of Water Resources: History, Development, Management, and Policy. John Wiley & Sons.
- Daniel P. Loucks , Eelco van Beek (2017) Water Resources Systems Planning and Management: An Introduction to Methods, Models, and Applications. Springer.
- Jain, R.K. (2021) Overview of Water Resources Management in India. Springer.
- Jan Hassing, Niels Ipsen, Torkil Jønch Clausen, Henrik Larsen and Palle Lindgaard-Jørgensen (2009) “Integrated Water Resources Management in Action”. prepared by DHI Water Policy and

UNEP-DHI Centre for Water and Environment, UN World Water Assessment Programme Dialogue Paper.

- Khadse GK, Labhasetwar PK, Wate SR. (2012) Water resource management: an Indian perspective. J Environ Sci Eng.
- Pennington, K. L., Cech, T. V., & Heins, C. (2021). Introduction to Water Resources and Environmental Issues. Cambridge University Press.
- Wolfram, M. (2009). Water Resources: Efficient, Sustainable, and Equitable Use. London : Haus Pub.

PAPER - GEOC405X1 (DSC 3): GEOTECTONICS & GEOMORPHOLOGY

GEOTECTONICS:

- Bloom, Arther L., 2003. Geomorphology – A systematic analysis of Late Cenozoic Landforms, 3rd Edn.
- Chorley, R., Schumm, S. and Sugden, D.E. 1994. Geomorphology, Methuen, London: 605p.
- Cook and Doorncamp. 1988. Geomorphology in Environment Management, London
- Holmes, Arthur (1978): Holmes Principles of Physical Geology, Francis & Taylor.
- Kale, V.S. and Gupta, A. 2001. Introduction to Geomorphology, Orient Longman Ltd., Hyderabad: 274p.
- Keary, P. and Vine, M. 1997. Global Tectonics, 2nd edition, Blackwell Scientific Publications, Oxford: 302p.
- Lowrie, W. (2007): Fundamentals of Geophysics, Cambridge University Press. Ollier, C.D. 1981: Tectonic Geomorphology, Longman Scientific & Technical, London:
- Summerfield, M.A. (Editor) 1991. Global Geomorphology : An Introduction to the Study of Landforms, John Wiley and Sons Ltd., New York: 560p.
- Valdiya, K.S. 1998. Dynamic Himalaya, University Press (India) Ltd., Hyderabad: 178p

GEOMORPHOLOGY:

- Anderson, R.S. and Anderson, S.P. 2010. Geomorphology, the Mechanics and Chemistry of Lanscape, Camdridge: Cambridge University Press.
- Bierman, P.R. and Montgomery, D.R. 2014. Key Concepts in Geomorpholgy, New York: W.H. Freeman and Company Publishers.
- Bloom, Arther L., 2003. Geomorphology – A systematic analysis of Late Cenozoic Landforms, 3rd Edn.
- Chorley, R., Schumm, S. and Sugden, D.E. 1994. Geomorphology, Methuen, London: 605p.

- Chorley, R.J. and Kennedy, B.A. (1971) Physical Geography: a System Approach. London: Prentice Hall.
- Coates , D.R.1976 Geomorphology and Engineering. Stroudsburg, pa.: Dowden, Hutchinson and RossEdition,Wiley, Chichester.
- Goudie,A.(Ed)(1990):Geomorphological Techniques,2nd edition,AllenUnwinCrows Nest(Australia).
- Holmes, Arthur (1978): Holmes Principles Of Physical Geology, Francis & Taylor.
- Huggett,R(2006): Fundamentals of Geomorphology,Routledge,London.
- Kale, V.S. and Gupta, A. 2001. Introduction to Geomorphology, Orient Longman Ltd., Hyderabad: 274p.
- Kale, V.S. and Gupta, A. 2001. Introduction to Geomorphology, Orient Longman Ltd., Hyderabad: 274p.
- Keary, P. and Vine, M. 1997. Global Tectonics, 2nd edition, Blackwell Scientific Publications, Oxford:302p.
- Knighton, D.1998 : Fluvial Forms and Processes: A New Perspective, Arnold, London: 385p.
- Leopold, L.B., Wolman, M.G. and Miller, J.P. 1964. Fluvial Processes in Geomorphology, Sanfransisco: W.H. Freeman & Co.
- Maiti, R. K. 2016. Modern Approaches to Fluvial Geomorphology. New Delhi: Primus.
- Morisawa, M. (editor) 1994. Geomorphology and Natural Hazards, Elsevier, Amsterdam: 355p.
- Morisawa, M. 1985. River Form and Process, London: Longman.
- Morisawa, M. 1985. Rivers, Longman, London: 222p
- Morisawa, M. 1985. Streams, their Dynamics and Morphology, New York: McGraw-Hill.
- Murthy, K.S. 1998. Watershed Management in India, 3rd edition, Wiely Eastern Ltd. / New Age International Ltd., New Delhi: 198p
- Newson, M. 1992. Land Water and Development, River Basin Systems and their Sustainable Management, Routledge, London: 350p.
- Ollier, C.D. 1981: Tectonic Geomorphology, Longman Scientific & Technical, London:
- Ollier, C.D. 1981: Tectonic Geomorphology, Longman Scientific & Technical, London: Paul,
- Ollier, C.D.(1969). Weathering, Edinburgh: Oliver & Boyd.
- Pethick, J. 1984. An Introduction to Coastal Geomorphology, Edward Arnold, London: 259 p.
- Ritter, D.F. 1986 Process Geomorphology. Dubuque, Iowa: Wm. C. Brown Publishers.
- Ritter,D.F.,Kochel,R.C.andMiller,J.R.(2006):Process Geomorphology,4th Edition, Waveland Press,N.Y.

- Scheidegger, A.E. (1961) Theoretical Geomorphology. Berlin: Springer Verlag.
- Schumm S.A. 1977. The Fluvial System, A Willey Interscience Publication, New York: John Wiley & Sons.
- Schumm, S.A. 1977. Fluvial System, New York: Wiley.
- Schumm, S.A. 1980. Some Applications of the Concept of Geomorphic Threshold, in Coates, D.R. and Vitek, J.D. (eds), Thresholds in geomorphology. Boston: George Allen & Unwin, pp. 473-85.
- Selby, M.J. 1985. An Introduction to Geomorphology, Clarendon, Oxford: 607p.
- Selby, M.J. 1985. Earth's Changing Surface, Oxford: Clarendon Press.
- Small,R.J., (1992) The Study of Landforms. Pp, 154-182.
- Sparks, B.W. 1972. Geomorphology, London: Longman.
- Starkel, L. and Basu, S. 2000 Rains, Landslides and Floods in the Darjeeling Himalaya, Indian National Science academy, New Delhi: 168p.
- Summerfield, M.A. (Editor) 1991. Global Geomorphology : An Introduction to the Study of Landforms, John Wiley and Sons Ltd., New York: 560p.
- Thomas,D.S.G.(Editor)(2008):Arid Zone Geomorphology: Process, Form and Change in Drylands, 2nd
- Thornbury, W.D. (1969): Principles of Geomorphology, Wiley Eastern Limited, New Delhi: 594 p

PAPER - GEOC405X8 (DSC 3): SEDIMENTOLOGY

- Collinson, J.D and Thompson, D.B. (1989): Sedimentary structures, CBS Publishers and Distributors, New Delhi.
- Folk, L. Robert (1978): Petrology of sedimentary rocks, Hemphill Publishing Company, Austin, Texas.
- Lindholm Roy C. (1986): A practical approach to sedimentology, C B S Publishers and Distributors New Delhi
- Maclane, M (1995): Sedimentology, Oxford University Press, New York, Oxford.
- Miall, A.D. (2006): Geology of the fluvial deposits: Sedimentary facies, basin analysis and petroleum geology, Springer.
- Reading, H.G. (1996) Sedimentary environments: Processes, Facies and Stratigraphy, Blackwell Science.
- Sengupta, S (1994): Introduction to sedimentology, Oxford and IBH Publishing New Delhi

PAPER - GEOO406VC (IKS): INDIAN KNOWLEDGE SYSTEM IN NATURE CONSERVATION

- Chaudhari, S. K., & Sharma, D. K. (2019).*Indigenous knowledge and natural resource management in India*. Indian Council of Agricultural Research (ICAR).
- Gadgil, M., & Guha, R. (1995).*Ecology and equity: The use and abuse of nature in contemporary India*.Routledge.
- Gadgil, M., Rao, P. R. S., Utkarsh, G., Pramod, P., & Chhatre, A. (2000).*People and protected areas: Towards participatory conservation in India*. International Institute of Environment and Development (IIED).
- Jodha, N. S. (1992). *Common property resources: A missing dimension of development strategies*. World Bank Discussion Papers, No. 169.The World Bank.
- Posey, D. A. (Ed.).(1999). *Cultural and spiritual values of biodiversity*.United Nations Environment Programme (UNEP) & Intermediate Technology Publications.
- Radhakrishnan, C. P. (2006). *Sacred groves of India: A travelling exhibition*. Ministry of Environment & Forests, Government of India.
- UNESCO.(2000). *Traditional ecological knowledge for managing biosphere reserves in South and Central Asia*.UNESCO – MAB Programme.

PAPER- GEOO407NC (NCC): VIDYASAGAR LIFE AND PHILOSOPHY

- Revisiting Modern Indian Thought : Themes and Perspectiveve. (Ed. Suratha Kumar Malik and Ankit Tomar), Routledge, New York and Londan. 2022 (First South Asian Edition)
- Vidyasagar o Bengali Sarnaj, Binoy Ghosh. Orient Blacksoan 2011
- Amalesh Tripathi: Vidyasagar: the Traditional Moderniser. Cambridge University Press, 2011
- Brian A.Hatcher (Trans): Vidyasagar : The Life and After Lile of Eminent Indian. Routledge. New Delhi, 2014
- Asok Sen: Iswar Chandra Vidyasagar and I is Elusive Milestone. Riddhi-lndian, 28 Bcniatola Lane, Cal-9
- Binoy Ghosh: Vidyasagar O Bengali Sarna, Orient Blacksoan. 2011

SEMESTER- II (275 Marks)

PAPER - GEOC451X1 (DSC 4): GEOGRAPHICAL THOUGHT & ENVIRONMENTAL ETHICS

GEOGRAPHICAL THOUGHT:

- Berry, B.L.J.(1973) A Paradigm of Modern Geography. In R.J. Chorley(ed), Directions in Geography. Lodon, Methuen 3-22.
- Chorley,R.J.andHagget,P.(editors)(1965):FrontiersinGeographicalTeaching,OUP,Oxford:231p.Delhi
- Golledge,R.G. and Stimson, R.S. (1997) Spatial Behaviour: a geographic perspective, New York: Guilford Press
- Gould, P.R. (1999) Becoming a Geographer, Syracuse: Syracuse University Press
- Gregory D. and Walford, R. (editors) (1988): Horizons in Human Geography, Macmillan, London: 390p.Hussain,M. (1995):EvolutionofGeographicalthought,3rdedition,RawatPub.Co.,NewDelhi:432p.
- Hartshorne, R. (1939): Nature of Geography, Association of American Geographers, Lancester, PA.
- Harvey D. (1996): Justice, Nature and the Geography of Difference, Oxford: Blackwell
- Harvey, D. (1969): Explanations in Geography, London, Edward Arnold
- James, P. (1972): All possible worlds: Ahistory of geographical ideas. Indianapolis: Bobbs Merrill.
- Johnston, R..J (1997): Geography and Geographer: Anglo American Human Geography, Arnold pub.
- Johnston,R.J. (ed.)(2006):Dictionaryof Human Geography,Blackwell.
- Maiti, R.K. and MoitraMaiti, M. (2018): Development of Geographical Thought, Contexualisation and Synthesis of Philosophies, Nabodaya Publications, Kolkata: 576P.
- Peet, R. (1978): Radical Geography: Alternative viewpoints on contemporary social issue. London: Methuen
- Peet, R. (1998): Modern Geographical Thought, Oxford: Blackwell.
- Soja, E.W.(1989): Post modern Geographies: The reassertion of space in social theory. London: Verso
- Stoddart,D.R. (1986):OnGeographyanditsHistory,Basil Blackwell,Oxford:236p.

ENVIRONMENTAL ETHICS:

- Farmer, A. (1997): Managing Environmental Pollution, Routledge, London: 246p.
- Ghosh, S.K. (2007): Environmental Act in India, Joshi, A. (2008): Global Environmental Agreements: Insight and Implication, Eastern Book Corporation
- Marsh, W.M. and Grossa, J.M. (1996): Environmental Geography: Science, Landuse and Earth Systems, John Wiley & Sons.
- Maryk, Theodore (1996): Major Environmental Issues Facing 21st Century, Prentice Hall

- Park, C. (1998): The Environment: Principles and Applications, Routledge, London:
- Pickering, K. and Owen, L.A.(1997) : An Introduction to Global Environmental Issues, 2nd edition, Routledge, London. Prabhakar, V.R. (1998): Social and Community Forestry, Indian Pub. Distrb., New Delhi: 224p.
- Roberts, N. (editor) (1994): The Changing Global Environment, 3rd edition, Blackwell Pub. Co., London: 531 p.
- Santra, S.C. (2001): Environmental Science; New Central Book Agency, Kolkata.

PAPER - GEOC451X8 (DSC 4): SPATIAL ANALYSIS & MODELLING

- Basins, T., & Basin, G. (n.d.). Water availability, demand and adaptation option assessment of the Ganges Basin under climate change Technical Report-Hydrological Modelling.
- Clark, C.D. and Wilson, C.(1994): Spatial Analysis of Lineaments: Computer and Geosciences, V.20.No.7/8,p. 1237-1258.
- Cliff, A.D. and J.K.Ord (1981): Spatial Processes: Models and Applications. London, Pion Ltd.
- Foresman,T.W.(ed) (1998): History of GIS, Prentice-Hall, Upper saddle river, NJ,
- Getis, A. and B. Boots (1978): Models of Spatial Processes: An Approach to the study of Point, Line andArea Patterns. Cambridge, Cambridge University Press.
- John, J.C.(2002):Statistics and data nalysis in Geology, Singapore, JohnWiley& Sons(Asia).
- Kibii, J. K., Kipkorir, E. C., &Kosgei, J. R. (2021). Application of soil and water assessment tool (SWAT) to evaluate the impact of land use and climate variability on the kaptagat catchment river discharge. Sustainability (Switzerland), 13(4), 1–19. https://doi.org/10.3390/su13041802
- Marcolongo, B. And Mantorani, F. (1997): Photogeology: Remote Sensing Application in Earth Science, Oxford and IBH Pub. Pvt. Ltd., New Delhi: 195p.
- Martin, D. (1991): Geographical Information Systems and their Socioeconomic Applications. London, Routledge.
- Masser, Ian and Blakemore, Michael (1991): Handling Geographical Information: Methodology and Potential Application, 3rd ed., Longman Scientific and Technical.
- Neitsch, S. ., Arnold, J. ., Kiniry, J. ., & Williams, J. . (2011). Soil & Water Assessment Tool Theoretical Documentation Version 2009. Texas Water Resources Institute, 1–647. https://doi.org/10.1016/j.scitotenv.2015.11.063
- Online: https://swat.tamu.edu/media/114860/usermanual_swatcup.pdf
- Robert A. Schowengerdt,(1997): Techniques for Image Processing and Classification in Remote Sensing, Academic Press.
- Watson, D.F. (1992): Contouring: A Guide to the Analysis and Display of Spatial Data, Oxford, PergamonPress.
- Watson, G.S. (1970): Orientation Statistics in the Earth Sciences, Bull.Geol. Inst.Uppsala, V.2. No. 9,p.73-89.

- Watson, G.S. (1983): Statistics on Spheres, New York, John Wiley & Sons

PAPER - GEOC452X1 (DSC 5): HYDROLOGY & OCEANOGRAPHY

HYDROLOGY:

- Abdul Aziz, O. I., & Burn, D. H. (2006). Trends and variability in the hydrological regime of the Mackenzie River Basin. Journal of Hydrology, 319(1–4), 282–294. https://doi.org/10.1016/j.jhydrol.2005.06.039
- Alternate Water Reuse, New society publishers, Gabriola Island.
- Aridity index. https://en.wikipedia.org/wiki/Aridity_index
- Bedinent, P.B.et.al. (2008): Hydrology and Floodplain Management, Prentice Hall,Upper Saddle River, NJ07458.
- Biswas,A.K. (1972): History of Hydrology, North Holland Pub.Cc. Amsterdam.
- Boca Raton, F.L Viessman and Lewis (1996): Introduction to Hydrology, Harper Collins, Newyork.
- Chow V.T., Maidment ,D.R. and Mays, L.W. (1988): Applied Hydrology, Mc Graw Hill, Newyork.
- Dingman, SL. (2002): Physical Hydrology, 2nd Edition, Prientice Hall, EnglewoodCliffs
- Hamed, K. H. (2008). Trend detection in hydrologic data: The Mann-Kendall trend test under the scaling hypothesis. Journal of Hydrology, 349(3–4), 350–363. https://doi.org/10.1016/j.jhydrol.2007.11.009
- Hatfield, J. L., &Dold, C. (2019). Water-Use Efficiency: Advances and Challenges in a Changing Climate. Frontiers in Plant Science, 10. https://doi.org/10.3389/fpls.2019.00103
- Hyot, W.G. and W. Langbain (1955): Floods, Prentice Hall University Press, Princeton.
- International Ltd., New Delhi: 198p.
- Keith, D. and Mays,L.W. (2004): Ground water hydrology, 3rd Edition, Wiley, Chichester.
- Kintede-Levario, H. (2007): Design for Water: Rain Water Harvesting, Storm Water Catchment and
- Mays, L.W. (1996): Water Resources Handbook, Mc Graw Hill, Newyork.
- Murthy, K.S. (1998): Watershed Management in India, 3rd edition, Wiely Eastern Ltd. / New Age
- Pal, I., & Al-Tabbaa, A. (2010). Regional changes in extreme monsoon rainfall deficit and excess in India. Dynamics of Atmospheres and Oceans, 49(2–3), 206–214. https://doi.org/10.1016/j.dynatmoce.2009.07.001
- Pethick, J. (1984): An Introduction to Coastal Geomorphology, Edward Arnold, London: 259 p

- Pohlert, T. 2020. Non-parametric change point analysis of time series data. https://cran.r project.org/web/packages/trend/vignettes/trend.pdf
- R Maity, 2022 Statistical Methods in Hydrology and Hydroclimatology, Springer, https://link.springer.com/book/10.1007/978-981-16-5517-3
- Singh, V.P. and D.K. Frevest (2006): Watershed Models, CRC Press,
- Taylor, WA. Change point analysis. https://variation.com/wp-content/uploads/change-point-analyzer/change-point-analysis-a-powerful-new-tool-for-detecting-changes.pdf
- Todd, D.K. (2004): Groundwater Hydrology, 3re Edition, Wiley, Chichester
- Water use efficiency and indices. http://eagri.org/eagri50/AGRO103/lec09.pdf

OCEANOGRAPHY:

- Introduction to Ocean Sciences (Second Edition), 2007: Douglas A. Segar W.W. NORTON AND COMPANY, NewYork
- Invitation to Oceanography (Fourth Edition), 2006: Paul R. Pinet; Jones And Bartlett Publishers
- The World's Oceans (International Edition), 2005: Keith A. Sverdrup, Alyn C. Duxbury, Alison B. Duxbury. McRAW-HILL

PAPER - GEOC452X8 (DSC 5): HYDROLOGICAL TECHNIQUES

- Abdul Aziz, O. I., & Burn, D. H. (2006). Trends and variability in the hydrological regime of the Mackenzie River Basin. Journal of Hydrology, 319(1–4), 282–294. https://doi.org/10.1016/j.jhydrol.2005.06.039
- Aridity index. https://en.wikipedia.org/wiki/Aridity_index
- Bedinent, P.B.et.al. (2008): Hydrology and Floodplain Management, Prentice Hall,Upper Saddle River, NJ07458.
- Biswas,A.K. (1972): History of Hydrology, North Holland Pub.Cc. Amsterdam
- Boca Raton, F.L Viessman and Lewis (1996): Introduction to Hydrology, Harper Collins, Newyork.
- Chow V.T., Maidment ,D.R. and Mays, L.W. (1988): Applied Hydrology, Mc Graw Hill, Newyork.
- Dingman, SL. (2002): Physical Hydrology, 2nd Edition, Prientice Hall, EnglewoodCliffs
- Hamed, K. H. (2008). Trend detection in hydrologic data: The Mann-Kendall trend test under the scaling hypothesis. Journal of Hydrology, 349(3–4), 350–363. https://doi.org/10.1016/j.jhydrol.2007.11.009
- Hyot, W.G. and W. Langbain (1955): Floods, Prentice Hall University Press, Princeton.

- Keith, D. and Mays,L.W. (2004): Ground water hydrology, 3rd Edition, Wiley, Chichester.
- Kintede-Levario, H. (2007): Design for Water: Rain Water Harvesting, Storm Water Catchment, and alternate Water Reuse, New society publishers, Gabriola Island.
- Mays, L.W. (1996): Water Resources Handbook, Mc Graw Hill, Newyork.
- Murthy, K.S. (1998): Watershed Management in India, 3rd edition, Wiely Eastern Ltd. / New Age International Ltd., New Delhi: 198p.
- Pal, I., & Al-Tabbaa, A. (2010). Regional changes in extreme monsoon rainfall deficit and excess in India. Dynamics of Atmospheres and Oceans, 49(2–3), 206–214. https://doi.org/10.1016/j.dynatmoce.2009.07.001
- Pethick, J. (1984): An Introduction to Coastal Geomorphology, Edward Arnold, London: 259 p
- Pohlert, T. 2020. Non-parametric change point analysis of time series data. https://cran.r-project.org/web/packages/trend/vignettes/trend.pdf
- R Maity, 2022 Statistical Methods in Hydrology and Hydroclimatology, Springer, https://link.springer.com/book/10.1007/978-981-16-5517-3
- Singh, V.P. and D.K. Frevest (2006): Watershed Models, CRC Press,
- Taylor, WA. Change point analysis. https://variation.com/wp-content/uploads/change-point-analyzer/change-point-analysis-a-powerful-new-tool-for-detecting-changes.pdf
- Todd, D.K. (2004): Groundwater Hydrology, 3re Edition, Wiley, Chichester

PAPER - GEOE453A0 (DSE 3): REGIONAL PLANNING & DEVELOPMENT

- Agarwal S.K. (2012): Regional Development and Planning in India, selected Essays by V. Nath.
- Bhat, L.S. (1973): Regional Planning in India, Statistical Pub. Society.
- Chand, M. and Puri, V.K. (2012): Regional Planning in India, Vikas, New Delhi
- Chandana, R.C.(2000): Regional Planning and Development, Kalyani Publishers.
- Glasson, J. (1974): An Introduction to Regional Planning, Hutchinson, London.
- Greed (2000): Introducing Planning, Athlone Press, London.
- Hall, P. (1974): Urban and Regional Planning, Penguin, London.
- Kulshresta S.K. (2012): Urban and Regional Planning in India, Sage, India
- Mishra, R.P. (1969): Regional Planning, Concept, Techniques, Policies, the University of Mysore Press.
- Misra,R.P,Sundaram and Rao (1974): Regional Planning In India, Viking, Delhi.
- Mitra, A. (1971): Levels of Regional Development India, Census of India.
- Tim, Hall (2006): Urban Geography, Routledge.

PAPER - GEOE453B0 (DSE 3): (DSE 3SETTLEMENT GEOGRAPHY& TRANSPORT GEOGRAPHY

- Adler, H.A (1987): Economic Appraisal of Transport Project, John Hapkins Press. Washington.
- Adler, H.A (1987): Economic Appraisal of Transport Project, John Hapkins Press. Washington.
- Brian, K.R (1996): Landscapes of Settlements: Prehistory to the Present, Routledge, London
- Dasgupta, A.K. and Pearee, D.W. (1972); Cost Benefit analysis, theory and practice; Mac Millan, London. Flahesly CAO (2006): Transport Planning and Traffic Engineering, Butterworth-Heinemann
- Dasgupta, A.K. and Pearee, D.W. (1972); Cost Benefit analysis, theory and practice; Mac Millan, London.
- De Blij H.J. (1995): The Earth: An Introduction to its Physical and Human Geography, John Wiley and Sons Inc.,nNew
- De Blij H.J. (1996): Human Geography: Culture, Society and Space, John Wiley and Sons Inc., New York:531 p.
- Flahesly CAO (2006): Transport Planning and Traffic Engineering, Butterworth- Heinemann
- Ghosh, S. (1998): Introduction to Settlement Geography, Orient Longman Ltd., Calcutta: 158p.
- Gwillian, K.M. (Ed.) (1993): Transport Policy and Global Warming, European Conference of Ministers of Transport, Paris.
- Gwillian, K.M. (Ed.) (1993): Transport Policy and Global Warming, European Conference of Ministers ofTransport, Paris.
- Hudson, F.S. (1970): Geography of Settlements, Macdonald and Evans Ltd., Plymouth
- Hussain, M. (1994): Human Geography, Rawat Pub. Co., New Delhi: 485p.
- Lays M.G. (1993): Wags of the World, Primarera Press, Sydwen
- Lays M.G. (1993): Ways of the World, Primarera Press, Sydwen
- Misra. H.N. (ed) (1987): Contributions to Indian Geography, Volume 9: Rural Geography, Heritage Pub.,New Delhi.
- Orient Blackshawn, Hyderaband.
- Pearce D.W. and Markyanda, A. (1989): Environmental policy Benefits, Manetany valuation OECD ,Paris. While, P. (1986): Public Transport Planning, Management and operation, Hatechinson, London.
- Pearce D.W. and Markyanda, A. (1989): Environmental policy Benefits, Manetany valuation OECD ,Paris.

- Racine, J. (ed) : Calcutta 1981, Concept Pub. Co., New Delhi.
- Ramachandram, R. (1999): Urbanization and urban systems in India, Oxford University Press, New DelhiVerma, L (2009): Urban Geography, Rawat publication, Jaipur
- Rodwin (2006): Shelter, Settlement and Development, Rawat Pub.
- Roy Chaudhuri, J. (2001): An Introduction to Development and Regional Planning-with special reference to India,
- Singh, R. Y. (1994): Geography of Settlements, Rawat Pub. Co., New Delhi: 335p.
- Singh, R.L. et. al. (ed) (1976): Geographic Dimensions of Rural Settlements, National GeographicalSociety of India, Varanasi.
- While, P. (1986): Public Transport Planning, Management and operation, Hatechinson, London.

PAPER - GEOE454A0 (DSE 4): RURAL DEVELOPMENT

- Ahmed, Rais (1996). Comparatives and integrated rural development programme, Mittal Publications, NewDelhi.
- Chand, M. and Puri, V.K. (1988): Regional Planning in India, Vikas, New Delhi
- Desai, Vasant (1991). Fundamentals of rural development: a system approach, Himalaya PublishingHouse, Bombay.
- Dutta, Siba kanta (1986). Co-operative societies & rural development, Mittal Publications, New Delhi.
- Kar, Samit (1991). Rural development in West Bengal : a quest, Sarat Book House, Kolkata.
- Kumar, Sunil (1990). Regional rural banks and rural development, Deep and Deep Publications, New Delhi
- Lakshman, T.K.., Narayan, B.K.. (1984). Rural development in India : a multi-demensional analysis, Himalaya Publishing House, Bombay
- Mahajan, V.S(1996). Agriculture,rural development and panchayati raj, Deep and Deep Publications, NewDelhi.
- Ministry of rural development, Government of India, web add: http://rural.nic.in/
- Ray, C.N (1994). Politics of rural development : The case of anti-Poverty programme in West Bengal andGujarat, Rawat Publications, Jaipur.
- Reddy, K. Venkata(1988). Rural development in India, Himalaya Publishing House, Bombay.

- Riley, John M (2002). Stakeholders in rural development : critical collaboration in state-NGO partnerships, Sage Publications India, New Delhi
- Saudhu, Baldere S (1996). Banking and rural development, Deep and Deep Publications, New Delhi.
- Singh, Katar (1986). Rural development : principles, policies and management, Sage Publications IndiaNew Delhi.
- Subramanian, S (1988). Rural development : an inside Look at Problems and prospects, Yatan Publications, New Delhi.
- Upadhyay, H.C (1991). Modernization and rural development, Anmol Publications, New Delhi.
- Vijay, Chand Mal (1989). Rural development administration in India, Akashdeep Publishing House, NewDelhi.
- Yadav, Subah Singh., Gurjar, Ram Kumar (1997). Rural development and poverty alleviation, PointerPublishers, Jaipur.
- Yugandhar, B.N., Mukherjee, Neela (1991). Studies in village India : Issues in rural development, ConceptPublishing, New Delhi.

PAPER - GEOE454B0 (DSE 4): AGRICULTURAL GEOGRAPHY

- Agrawal A.N (2005): Indian agriculture: problems, progress and prospects, Vani Educational Books New Delhi
- Bhatia B.M. (2008): Indian agriculture: a policy perspective, Sage Publications India New Delhi.
- Deininger Dina and Umali Maguire Charles (2006): Agriculture in liberalizing economics: changing roles for governments, World Bank Washington.
- Gautam, Alka (2012): Agricultural Geography, Sharda Pustak Bhawan, Allahabad.
- Grig, B, David (1995): An Introduction to Agricultural Geography, Routledge,
- Hussain, Majid (2003): Agricultural Geography, Anmol Publications Pvt Ltd, India.
- Jha D N (2001): Agriculture and Regional Planning, Mittal Publications New Delhi.
- Joshi, V. Mahesh (1999): Green revolution and its impacts. New Apcon, New Delhi.
- Kamath M.G. (2000): A dictionary of Indian agriculture, Allied Publishers New Delhi.
- Rao C H Hanumantha (2005): Agriculture, food security, poverty, and environment: essays on post-reform India, Oxford University Press New Delhi.
- Report: Asian Development Bank (2010): Agriculture, food security, and rural development, Oxford University Press New Delhi.
- Shiva, Vandana (1991): The Violence of Green Revolution: Third World Agriculture, Ecology and Politics,

- Singh, J. S and Dhillon, S. S. (2004): Agricultural Geography, Tata McGraw-Hill Education.
- Zed Books.

PAPER - GEOE455A0 (DSE 5): SOCIAL & CULTURAL GEOGRAPHY

- Alison,B et.al (2003): Cultural Geography in practice, Arnold, New Delhi
- Bist,B.S.andPanth,V.K(1998): Backward Communities in India, Rawat Pub.
- Carter, J. And Jones, T. (1989):Social Geography: An Introduction to Contemporary Issues , EdwardArnold, London
- De Blij H.J. (1996): Human Geography: Culture, Society and Space, John Wiley and Sons Inc., New York:531 p.
- Guha-Banerje, S. (2001): Space, society and geography, Rawat Publication, Jaipur.
- Harvey,G.(2006): Readings in Indigenous Religion ,Rawat Pub.
- Hichcock,S.(2006): Geography of Religion, Rawat Pub.
- Hussain, M. (2005): Cultural Geography, Anmol Publication, New Delhi
- Jackson, A.K and et.al (2005): Cultural Geography: A critical dictionary of key concepts, Tauris, London
- Knox,Paul.L.(1975): Social Wellbeing: Human Spatial Perspectives, Oxford University Press. Mahanti.M (ed)(1994): Class, Caste and Gender- Tribal Issues in India, Sage Pub.
- Mike,C. (2000): Cultural Geography, Routledge, London
- Mitchell, D. (2000): Cultural Geography: A Critical Introduction, Wiley
- Norton, W (2006): Cultural Geography: Environments, Landscape, Identities and Inequities, OxfordUniversity Press, Oxford.
- Norton, W (2006): Cultural Geography: Environments, Landscape, Identities and Inequities, Oxford University Press, Oxford.
- Perry, A.J and Perry, E.K (2010) : Contemporary Society: An Introduction to Social Science, Pearson Education,Noida, India
- Sahu, C.(2006): Encyclopedia of Indian tribes
- Singh, G.N and Nath, Kashi (2004): Cultural Geography-Form and Process, Concept Publication, NewDelhi
- Tiwari, S.K.(1998): Antiquity of Indian Tribes.ISBN-81-7625-016-3. Smith, S.J and Pain,R (Eds) (2010): Social Geographies, Sage, Los Angles

PAPER - GEOE455B0 (DSE 5): GENDER, SPACE AND CRIME

- Little, J. (2002). Rural geography: rural gender identity and the performance of masculinity and femininity in the countryside. Progress in Human Geography, 26(5), 665-670.
- Little, J., & Panelli, R. (2003). Gender research in rural geography. Gender, Place and Culture: A Journal of Feminist Geography, 10(3), 281-289.
- Little, J., Peake, L., & Richardson, P. (1988). Introduction: geography and gender in the urban environment. In Women in Cities (pp. 1-20). Palgrave, London.
- Nightingale, A. (2006). The nature of gender: work, gender, and environment. Environment and planning D: Society and space, 24(2), 165-185.
- Nightingale, A. J. (2017). Environment and gender. The International Encyclopedia of Geography; Wiley: New York, NY, USA.

PAPER - GEOC456X9 (SEC 1): FIELD VISIT/ INDUSTRY VISIT/CASE STUDY/ HANDS-ON PRACTICAL/ SKILL ENHANCEMENT COURSE:

ECOLOGICAL CENSUS TECHNIQUES:

- William J. Sutherland (2006): Ecological Census Techniques Edited by Cambridge 2nd edition Lagacherie Philippe, McBratney Alex and VoltzMarc(2006) : Digital Soil Mapping :An Introductory Perspective,Elsevier
- Singh, R.L. and Singh, R.P.B. 1992: Elements of practical Geography.
- Robinson, A.H., Morrison, J.L., Muehrcke, P.C., Kimerling, A.J. and Guptill, S.C. 1995: Elements of Cartography, John Wiley and Sons, New York.
- Basu, R. and Bhaduri, S. ed, 2007: Contemporary Issues and Techniques in Geography, Progressive Publishers, Kolkata.
- Gupta, K. K. and Tyagi, V. C. (1992): Working with maps, Survey of India Publication, Dehradun.
- Scull, P.; J. Franklin, O.A. Chadwick & D. McArthur (June 2003). Predictive soil mapping – a review. Progress in Physical Geography ,Sage Publications. Monkhouse, F.J. 1971: Maps and Diagrams, Methuen, London

SEMESTER- III (275 Marks)

PAPER- GEOC502X1 (DSC 6): METEOROLOGY & CLIMATOLOGY

- Barry, R.G. and Chorley, R.T. (1992): Atmosphere, Weather and Climate, 6th edition, Routledge, London: 392p.
- Critchfield, H.J. (1983): General Climatology, 4th edition, Prentice Hall India Ltd., New Delhi: 453p.
- Das, P.K. (1995): Monsoons, 2nd edition, National Book Trust, New Delhi: 347p. Lal, D.S. (1993) : Climatology, 3rd edition, Chaitanya Pub. House, New Delhi: 412p.
- IPCC AR 6 report, https://www.ipcc.ch/assessment-report/ar6/
- Lau, K.-M., and Kim, K.-M. (2006), Observational relationships between aerosol and Asian monsoon rainfall, and circulation, Geophys. Res. Lett., 33, L21810, doi:10.1029/2006GL027546.
- Linacre, E. and Geerts, B. (1997): Climates and Weather Explained, Routledge, London: 464p.
- Lutgens, F.K.. and Tarbuck, E.J. (1998): The Atmosphere: An Introduction to Meteorology, 7th edition, Prentice-Hall
- Moran, J.M. and Morgan, M.D. (1997) : Meteorology: The Atmosphere and the Science of Weather, 5th edition, Prentice-Hall Inc., Upper Saddle River: 530p.
- Wallace, J. M., & Hobbs, P. V. (2006). Atmospheric Science: An Introductory Survey: Second Edition. In Elsevier Academic Press. https://doi.org/10.1016/C2009-0-00034-8
- Wonsick, M. M., Pinker, R. T., and Ma, Y.: Investigation of the "elevated heat pump" hypothesis of the Asian monsoon using satellite observations, Atmos. Chem. Phys., 14, 8749–8761, https://doi.org/10.5194/acp-14-8749-2014, 2014

PAPER - GEOC502X8 (DSC 6): CLIMATE CHANGE ASSESSMENT TECHNIQUES

- Analysis, a N., Some, O. F., & Questions, K. E. Y. (2001). Climate Change. In Sciences. New York. http://www.metoffice.gov.uk
- Hansen, J., Sato, M., & Ruedy, R. (2012). Perception of climate change. Proceedings of the National Academy of Sciences of the United States of America, 109(37). https://doi.org/10.1073/pnas.1205276109

Online sources

1. https://climate.nasa.gov/evidence/
2. https://public.wmo.int/en/media/press-release/state-of-climate-2021-extreme-events-and-major-impacts
3. https://royalsociety.org/topics-policy/projects/climate-change-evidence-causes/basics-of-climate-change/
4. https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature
5. https://www.ipcc.ch/data/
6. https://www.mghihp.edu/academics-schools-departments-school-nursing/statistics-climate-change

PAPER - GEOE503A0 (DSE 6): PROCESS GEOMORPHOLOGY

- Anderson Robert S. and Anderson Suzanne P., 2010 Geomorphology (1st Edition, Kindle Edition) by , Cambridge University Press.
- Anderson, M.G. (1988) Modelling Geomorphological Systems, John Wiley & Sons, New York
- Chorley R.J. (Ed.) (1972) Spatial Analysis in Geomorphology., Methuen & Co., London.
- Chorley, R.J. Schumm,S.A. &Sugden, D.E. (1985): Geomorphology, Methuen & Co. Ltd., London, NewYork.
- Christopherson, R.W. (1995): Elemental Geosystems: A Foundation in Physical Geography, Prentice HallEnglewood Cliffs, New Jersey.
- Coates, D.R. and Vitek, J.D. (1980) (eds), Thresholds in Geomorphology, George Allen & Unwin,London.
- Crozier, M. J. (1986), Landslides: Causes, Consequences and Environment, Croom Helm, London.
- Gamen,H.F. (1974) The Origin of Landscapes-A Synthesis in Geomorphology, Oxford University Press.
- Greeley, Ronald (2013) Introduction to Planetary Geomorphology, Cambridge University Press
- Gupta, A. (2011) Tropical Geomorphology, Cambridge University Press
- Kale, V.S. (2018) (ed) Geomorphosites in India. IGI
- Knighton, D. (1990) Fluvial Forms and Processes, Hodder Education, UK.
- Leopold, L.B. Wolman, M.G. & Miller, J.P. (1964): Fluvial Processes in Geomorphology, W.H.Freeman
- Lobeck, A.K. (1939) Geomorphology, McGraw Hill, New York.
- Maiti, R.K. (2016) Modern Approaches to Fluvial Geomorphology, Primus Books.
- Mondal S. and Maiti, R.K. (2015) Semi-quantitative Approaches in Landslide Assessment and Prdiction,Springer.

- Morisawa, M. (1985) Rivers, Longman, London.
- Ollier, C. D. (1969) Weathering. Elsevier, New York.
- Pity A.F., 1971, Introduction to Geomorphology, Methuen, London.
- Ritter, D.F. (1986) Process Geomorphology, Wm. C. Brown Publisher, Dubuque, Iowa.
- Ritter, Kochel and Miller Process Geomorphology, 4th edition, Waveland Press 2006 (ISBN 13: 978-1- 57766-461 1).
- Robinson, Harry (1969): Morphology and Landscape, University Tutorial Press Ltd. London.
- Selby Michael John (1985) Earth's Changing Surface: An Introduction to Geomorphology, ClarendonPress.
- Selby, M.J. (2005) Hill slope materials and processes, Oxford University Press, Oxford.
- Selby, R.C. (1976), An Introduction to Sedimentology, Academic Press, London.
- Spark, B. W. (1986) Geomorphology, Longman, London.
- Sparks, B.W (1972) Geomorphology, Longman, London.
- Thomas Michael F. 2014 Geomorphology in the Tropics, , Wiley.
- Valdia, K.S. (2010) The Making of India: Geodynamic Evolution
- Wadia, D.N. (1993) Geology of India, Tata McGraw Hill Edition, New Delhi.
- Worcester, P. G. (1948): Textbook of Geomorphology, Princeton, D.Van, Nortrand.
- Zaruba, Q. et al (1969) Landslides and their control. Elsevier, Amsterdam

PAPER - GEOE503B0 (DSE 6): FOUNDATION OF URBAN GEOGRAPHY

- Ahuja,R (1999): Social Problem in India, Rawat, Jaypur
- Carter, H. (1981): Urban Geography, 3rd edition Arnold-Heinemann, New Delhi: 434p.
- Carter, H. (2002): Urban Geography, 4th edition Arnold-Heinemann, New Delhi: 434p.
- De Blij, H.J. and Muller, P.O. (1997): Geography: Realms Regions and Concepts, 8th edition, John Wileyand Sons Ltd., New York: 569p.
- Dickinson, J., Gould, B., Clarke, C., Mather, S., Prothero, M., Siddle, D., Smith, C. and Thomas-Hope, E. (1996): A Geography of the Third World, 2nd edition, Routledge, London: 334p.
- Dickinson, R.E. (1968): City and Region: A Geographical Interpretation, Routledge and Kegam Paul Ltd. London.
- Ghosh, S. (1998): Introduction to Settlement Geography, Orient Longman Ltd., Calcutta: 158p.
- Gore, Charles (1984). : Region in question, Routledge Publisher.

- Herbert, D. (1977): Urban Geography- A social Perspectives, David and charles, London
- Herbert, D. and Johnston, R,J. (1979): Geography and Urban Environment, John wiley, New York
- Hudson, F.S. (1970): Geography of Settlements, Macdonald and Evans Ltd., Plymouth:
- Kleniewski, N. (2005): Cities and Society, Blackwell,
- Knox, P. (1982): Urban Social Geography, Longman Scientific and Technical, Harlow.
- Linder, C (2006): Urban Space and Cityscapes, Pergamon Press
- Pacione, M. (2007): Urban Geography, Routledge,
- Palen, J(1992): The Urban World, Mc Grow Hill, New York
- Pub. Pvt. Ltd., New Delhi: 877p.
- Ramachandran R. (1989): Urbanisation and Urban Systems in India, Oxford University Press, New Delhi. Singh, R.L. (editor) (1971): India: A Regional Geography, National Geographical Society of India / UBS Pub. Distributors Ltd., New Delhi: 992p.
- Singh, R.L. et. al. (ed) (1976): Geographic Dimensions of Rural Settlements, National Geographical Society of India, Varanasi.
- Sovani, N.V. (1964): The Analysis of Over Urbanization: Economic Development and Cultural Change, Macionis, J.J and Parrillo, V.N (2010): Cities and Urban life, Pearson Education, New Jerse
- Spate, O.H.K. and Learmonth, A. T.A. (1967): India and Pakistan, 3rd edition, MunshiramMonoharlal
- Tewari, V. Weinston, J. and Prakash Rao, V.L.S. (1986): Indian Cities: Ecological Perspectives, Concept Pub. Co., New Delhi.

PAPER - GEOE503C0 (DSE 6): BASICS OF REMOTE SENSING AND PHOTOGRAMMETRY

- American Society of Photogrammetry (ASP), (1983): Manual Of Remote Sensing, second edition, ASP,Fallschurch, VA,
- Campbell, J .B. (1996): Introduction to Remote Sensing, 2nd edition, Taylor & Francis, London; 622p.
- Chaisman, N. (1992): Exploring Geographical Information Systems, John Wiley and Sons Inc., New York:198p.
- Chrisman, N.R. (1997): Exploring Geographic Information Systems; John Wiley and Sons. (Inc).

- Cracknelll, A.P., and L.W.B.Hayes, (1991): Introduction to Remote Sensing, Taylor and Francis,Washington, DC.
- Curran, P.J. (1980): Mulltispectral remote sensing of vegetation amount, Progress in Physical Geography
- Guha, P.K. (2003): Remote Sensing for the Beginner, Affiliated East-West Press Pvt. Ltd., New Delhi
- John, R. J. (1998): Introductory Digital Image Processing – A Remote Sensing Perspective, Prentice Hall
- Joseph, George, (2003): Fundamental of Remote Sensing, Orient Longman Pvt. Ltd.
- Lillesand, T.M. and Kieffer, R.W. (2003): Remote Sensing and Image Interpretation, 5th Edition, Wiley,nmNew York
- Marcolongo, B. And Mantorani, F. (1997): Remote Sensing Application in Earth Science, Oxford and
- Martin, D. (1991): Geographical Information Systems and their Socioeconomic Applications. London,Routledge.
- Rajan, M.S. (1995): Space Today, 2nd edition, National Book Trust, New Delhi, 344p.
- Robert A. Schowengerdt,(1997): Techniques for Image Processing and Classification in Remote Sensing, Academic Press.
- Sabins, F.F. (1997): Remote Sensing: Principles and Applications, 3rd edition, W.H. Freeman & Company,New York:
- Series. Lillesand, T.M. and Kieffer, R.W. (1979): Remote Sensing and Image Interpretation, 5th Edition, Wiley,New York
- Ulaby, F.T., Moore, R. K. and Fung, A.K. (1982): Microwave Remote Sensing Active and Passive, VolumeII, Radar

PAPER - GEOE503D0 (DSE 6): THEORIES IN LANDSCAPE ECOLOGY

- Bodkin, D. B. 1990. Discordant Harmonies. Oxford Univ. Press, New York. 241pp.
- Boitani, L. and T. K. Fuller. 2000. eds. Research Techniques in Animal Ecology: Controversies and consequences. Columbia University Press, New York. 442pp.
- Brown, J. H. 1995. Macroecology. Univ. Chicago Press, Chicago. 269pp.
- Changing landscapes: an ecological perspective. 1989. I.S. Zonneveld and R. T. T. Forman (eds). Springer-Verlag, New York. 286 pp.

- Cronon, W. 1983. Changes in the land: Indians, colonists, and the ecology of New England. Hill and Wang, New York. 241 pp.
- Ecological Society for Conservation Biology. Blackwell Scientific Publications, London.375pp.
- Edwards, P. J., R. M. May, and N. R. Webb. eds. 1994. Large-scale ecology and conservation biology. The 35th Symposium of the British
- Farina, A. 1998. Principles and methods in landscape ecology. Chapman and Hall, New York. 235.
- Forest island dynamics in man-dominated landscapes. 1981. R. L. Burgess and D. M. Sharpe (eds. . Ecological studies 41. SpringerVerlag, New York. 310 pp.
- Gaddis, J. L. 2002. The Landscape of History. Oxford University Press, New York, N.Y. 192 pp.
- Gilovich, T. 1991. How we know what isn't so: the fallibility of human reason in everyday life. The Free Press (div. of Macmillan, Inc. New York. 216 pp.
- Gleick, J. 1988. Chaos: making a new science. Penguin Books. 352 pp.Forman, R.T.T., and M. Godron. 1986. Landscape Ecology. John Wiley
- Harris, L. D. 1984. The fragmented forest: island biogeography theory and the preservation of biotic diversity. Univ. Chicago Press, Chicago, IL. 211 pp.
- hierarchical concept of ecosystems. Monogr. in Pop. Biol. #23.Princeton Univ. Press. 253 pp.
- Klopatek, J. M. And R. H. Gardner. eds. 1999. Landscape Ecological Analysis. Springer, New York. 400pp.
- Kuhn, T. S. 1962 (1970 ed) The structure of scientific revolutions.Univ. Chicago Press, Chicago, IL. 210 pp.
- Peak, D., and M. Frame. 1994. Chaos under control: the art and science of complexity. W. H. Freeman & Co., N. Y. 408pp.
- Pickett, S. T. A., J. Kolasa, and C. G. Jones. 1994. Ecological understanding: the nature of theory and the theory of nature.Academic Press, San Diego, CA. 206pp.
- Pickett, S.T.A., and P.S. White (eds. . 1985. The ecology of natural disturbance and patch dynamics. Academic Press, Inc. 472 pp.
- Quantitative methods in landscape ecology. 1991. M. G. Turner and R. H. Gardner (eds.) Ecological Studies 82. Springer-Verlag, New York. 536 pp.
- Szaro, R. C., and D. W. Johnson. 1966. Biodiversity in managed landscapes. Oxford University Press, Oxford. 778pp
- T. F. H. Allen, and T. W. Hoekstra. 1992. Towards a unified ecology. Columbia University Press, New York. 384pp.

- Turner, M. G., R. H. Gardner, and R. V. O'Neill. 2001. LandscapeEcology in Theory and practice. Springer, New York.401pp.
- Walters, C. 1986. Adaptive management of renewable resources.Macmillan Publ. Co., New York. 374 pp.

GEO - GEOE503E0 (DSE 6): CLIMATE SCIENCE& MODELLING

- IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R.Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, In press, doi:10.1017/9781009157896.
- Modest MF. 2003. Radiative heat transfer. 2nd ed. Amsterdam: Elsevier Academic Press.
- R Maity, 2022 Statistical Methods in Hydrology and Hydroclimatology, Springer, https://link.springer.com/book/10.1007/978-981-16-5517-3
- Seinfeld JH, Pandis SN. 1997. Atmospheric chemistry and physics. :1–1309.
- Viterbo P. 2002. The role of the land surface in the climate system. :1–19.
- Wallace JM, Hobbs P V. 2006. Atmospheric Science: An Introductory Survey. 2nd ed. Amsterdam: Elsevier Academic Press.
- Zucchetto J. 2005. A climate modelling primer. 3rd ed. Sussex: John Wiley & Sons, Ltd.

PAPER - GEOC504X9 (DSC 7): STATISTICS AND CARTOGRAPHIC TECHNIQUES

- Alvi. Z. (1995): Statistical Geography: Methods and Applications, Rawat Publication, New Delhi
- 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.
- Climate.gov, Meet the ENSO's neighbour, the Indian Ocean Dipole. https://www.climate.gov/news-features/blogs/enso/meet-enso%E2%80%99s-neighbor-indian-ocean-dipole
- Climate.gov, What is MJO and why do we care? https://www.climate.gov/news-features/blogs/enso/what-mjo-and-why-do-we-care

- Fotheringham, S. A and Brunsdon, C and Charlton, M. (2000): Quantitative Geography: Perspectives on SpatialData Analysis, SAGE.
- Gibson PB, Chapman WE, Altinok A, Delle Monache L, DeFlorio MJ, Waliser DE. 2021. Training machine learning models on climate model output yields skillful interpretable seasonal precipitation forecasts. Commun Earth Environ [Internet]. 2(1). http://dx.doi.org/10.1038/s43247-021-00225-4
- Haining, R.P. (2003): Spatial Data Analysis, Cambridge University Press.
- How to tackle climate change with machine learning? https://medium.com/the-research-nest/how-to-tackle-climate-change-using-machine-learning-8ab12e73d261
- John, C. D. (2002): Statistics and Data Analysis in Geology; John Wiley & Sons.
- Lakshmanan V, Gilleland E, McGovern A, Tingley M, editors. 2015. Machine Learning and Data Mining Approaches to Climate Science [Internet]. Cham: Springer International Publishing. http://link.springer.com/10.1007/978-3-319-17220-0_20
- Lee T, Singh VP. 2018. Statistical Downscaling for Hydrological and Environmental Applications. New York: CRC Press, Taylor & Francis Group.
- Lindsay, J.N. (1997): Techniques in Human Geography, Routledge
- Lund RB, von Storch H, Zwiers FW. 2003. Statistical Analysis in Climate Research. Cambridge: Cambridge University Press.
- Maraun, D., & Widmann, M. (2018). Statistical Downscaling and Bias Correction for Climate Research. Cambridge: Cambridge University Press. doi:10.1017/9781107588783
- Mehmood, A (1977): Statistical methods in Geographical studies, Rajesh Pub. New Delhi
- NCAR Climate Data Guide https://climatedataguide.ucar.edu/climate-data/nino-sst-indices-nino-12-3-34-4-oni-and-tni
- Pal, S.K. (1999): Statistics for Geoscientists, Concept publishing Company, New Delhi: 423p.
- R Maity, 2022 Statistical Methods in Hydrology and Hydroclimatology, Springer, https://link.springer.com/book/10.1007/978-981-16-5517-3
- Rolnick D, Donti PL, Kaack LH, Kochanski K, Lacoste A, Sankaran K, Ross AS, Milojevic-Dupont N, Jaques N, Waldman-Brown A, et al. 2019. Tackling Climate Change with Machine Learning. arXiv [Internet]. http://arxiv.org/abs/1906.05433
- Sarkar, A. (2006): Practical Geography; A systematic approach, Orient Longman Ltd, Hydrabad,
- Silk, J. (1979): Statistical techniques in Geography, George Allen and Unwin, London: 276p.
- Swan, A.R.H.; Sandilands, M. and McCabe, P. (1995): Introduction to Geological Data Analysis, Blackwell. 446p.
- Walford, P. (1995): Geographical Data Analysis, John Wiley and Sons Inc., New York: 446p.

PAPER - GEOE505X9 (DSE 7): SPECIAL PAPER BASED FIELDWORK/ INTERNSHIP

- 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

PAPER - GEOC501X0 (MOOCs): MOOC COURSE

PAPER - GEOC506X9 (SEC 2): SOCIAL SERVICE AND COMMUNITY ENGAGEMENT

- *Banks, S. (2012). Ethics and Values in Social Work.*
- *Chambers, R. (1994). Participatory Rural Appraisal (PRA): Analysis of Experience.*
- *Creswell, J.W. (2014). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches.*
- *Desai, V., & Potter, R.B. (2014). The Companion to Development Studies.*
- *Kothari, C.R. (2004). Research Methodology: Methods and Techniques.*
- *Moser, C.O.N. (2010). Community Knowledge, Governance, and Environment.*
- *Pain, R., & Francis, P. (2003). Reflections on Participatory Research.*

- *Singh, R.B. (Ed.) (2011). Geographies of Social Inclusion and Exclusion: Settlements and Social Service.*
- *Selected journal articles on community engagement, participatory GIS, and social geography.*

SEMESTER-IV (275 Marks)

PAPER – GEOC551X1 (DSC 8): ENVIRONMENTAL ENGINEERING AND ENERGY, WATER AND FOOD NEXUS

ENVIRONMENTAL ENGINEERING:

- Brady,N.C. and Well, R.R. (2005): The Nature and Properties of Soil, Pearson Education, Singapore.
- Masters, G .M. (1991): Introduction to Environmental Engineering and Sciences, Prentice Hall India Ltd. New Delhi:
- Nazaroff, W.W. and Alvarej, C.L. (2001): Environment Engineering Science; John Wiley & Sons, Newyork.
- Pielou, E.C. (1975): Ecological Diversity, John Wiley & Sons, Newyork
- Schwab,G.O. et.al. (1993): Soil and Water Conservation Engineering, 4th Edition, John Wiley & Sons, Newyork
- Sing,V.P. Yavada,R.N.(2003): Environmental Pollution, Allied Publishers Pvt. Ltd. New Delhi.
- Vesilind, P.A. and Morgan, S.M. (2004): Introduction to Environmental Engineering (2nd Edition), Thomson, Australia.

ENERGY, WATER AND FOOD NEXUS:

- Abdi, H., Shahbazitabar, M., &Mohammadi-Ivatloo, B. (2020). Food, energy and water nexus: A brief review of definitions, research, and challenges. Inventions, 5(4), 1–14. https://doi.org/10.3390/inventions5040056
- Davis, S. J., Lewis, N. S., Shaner, M., Aggarwal, S., Arent, D., Azevedo, I. L., Benson, S. M., Bradley, T., Brouwer, J., Chiang, Y. M., Clack, C. T. M., Cohen, A., Doig, S., Edmonds, J., Fennell, P., Field, C. B., Hannegan, B., Hodge, B. M., Hoffert, M. I., … Caldeira, K. (2018). Net-zero emissions energy systems. Science, 360(6396). https://doi.org/10.1126/science.aas9793
- DeAngelo, J., Azevedo, I., Bistline, J., Clarke, L., Luderer, G., Byers, E., & Davis, S. J. (2021). Energy systems in scenarios at net-zero CO2 emissions. Nature Communications, 12(1). https://doi.org/10.1038/s41467-021-26356-y
- Elsayed, H., Djordjevic, S., Savic, D., Tsoukalas, I., &Makropoulos, C. (2022). Water-food-energy nexus for transboundary cooperation in Eastern Africa. Water Supply, 22(4), 3567–3587. https://doi.org/10.2166/ws.2022.001
- 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

- https://hydroviz.org/Lessons/Index/National/Nexus
- https://www.teriin.org/article/water-food-energy-nexus-india
- https://www.watercalculator.org/footprint/nexus-reports-research/
- https://www.water-energy-food.org//ru/resources/training-materials-the-water-energy-food-ecosystems-wefe-nexus-from-research-to-practice
- Keskinen, M., Guillaume, J. H. A., Kattelus, M., Porkka, M., Räsänen, T. A., &Varis, O. (2016). The water-energy-food nexus and the transboundary context: Insights from large Asian rivers. Water (Switzerland), 8(5). https://doi.org/10.3390/w8050193
- Link, P. M., Scheffran, J., & Ide, T. (2016). Conflict and cooperation in the water-security nexus: a global comparative analysis of river basins under climate change. Wiley Interdisciplinary Reviews: Water, 3(4), 495–515. https://doi.org/10.1002/wat2.1151
- LIOTARD, K., &McGIFFEN, S. P. (2017). Conflict and Cooperation. Poisoned Spring, 10, 74–95. https://doi.org/10.2307/j.ctt183p64g.8
- Mc Kinsey. (2011). Water Security - the nexus.
- Online materials
- Pingali, P. L. (2012). Green revolution: Impacts, limits, andthe path ahead. Proceedings of the National Academy of Sciences of the United States of America, 109(31), 12302–12308. https://doi.org/10.1073/pnas.0912953109
- Ray, C. Muddu, S and Sharma, S. (2022). Food, Energy, and Water Nexus: A Consideration for the 21st Century. Springer Nature Switzerland AG 2022, https://doi.org/10.1007/978-3-030-85728-8
- Río-Gamero, B. Del, Ramos-Martín, A., Melián-Martel, N., & Pérez-Báez, S. (2020). Water-energy nexus: A pathway of reaching the zero net carbon in wastewater treatment plants. Sustainability (Switzerland), 12(22), 1–19. https://doi.org/10.3390/su12229377
- Saidmamatov, O., Rudenko, I., Pfister, S., &Koziel, J. (2020). Water-Energy-Food nexus framework for promoting regional integration in Central Asia. Water (Switzerland), 12(7), 1–11. https://doi.org/10.3390/w12071896
- Salam, P. A., Shrestha, S., Pandey, V. P., & Anal, A. K. (2000). Water-Energy-Food Nexus. Principles and Practices. In Book: Geophysical Monograph Series (Vol. 115).
- Taguta, C., Senzanje, A., Kiala, Z., Malota, M., &Mabhaudhi, T. (2022). Water-Energy-Food Nexus Tools in Theory and Practice: A Systematic Review. Frontiers in Water, 4(March), 1–21. https://doi.org/10.3389/frwa.2022.837316

PAPER – GEOC551X8 (DSC 8): ENVIRONMENTAL MONITORING AND ASSESSMENT

- Environmental Monitoring (2004):Edited By G. Bruce Wiersma, CRC Press
- Environmental Monitoring and Characterization (2004): Authors: Janick Artiola, Ian Pepper, Mark Brusseau, Elsevier
- Environmental Monitoring Handbook(2002) : 1st Edition by Frank R Burden, Ian McKelvie Ulrich Forstner , Alex Guenther ,Mc Graw Hill Professional
- NRC. 1993. a. Research to Protect, Restore, and Manage the Environment. National Academy Press, Washington, D.C.
- Oliver, C. D., and B. C. Larson. 1990. Forest Stand Dynamics. New York: McGraw Hill.
- Turner, B. L. II., editor. (ed). (1990.) The Earth as Transformed by Human Action. Cambridge University Press with Clark University. Cambridge, Massachusetts.

PAPER – GEOE552A0 (DSE 8): ADVANCED GEOMORPHIC TECHNIQUES

- Anderson Robert S. and Anderson Suzanne P., 2010 Geomorphology (1st Edition, Kindle Edition) by , Cambridge University Press.
- Anderson, M.G. (1988) Modelling Geomorphological Systems, John Wiley & Sons, New York
- Brierley, G.J. &Fryirs, K.A. (2005): Geomorphology and River Management, Blackwell Publishing,Oxford, UK.
- Chorley R.J. (Ed.) (1972) Spatial Analysis in Geomorphology., Methuen & Co., London.
- Coates, D.R. and Vitek, J.D. (1980) (eds), Thresholds in Geomorphology, George Allen & Unwin,London.
- Cook, R.U. & Doornkamp, J.C. (1974): Geomorphology in Environmental Management, an Introduction.Clarendon Press. Oxford. .
- Goudie, A.G. et al. (1990) (eds) Geomorphological Techniques, Unwin, Hyman, London.
- Hart, M.G. (1986): Geomorphology Pure and Applied, George Allen and Unwin, London.
- Knighton, D. (1990) Fluvial Forms and Processes, Hodder Education, UK.
- Lee, N. and George, C. (eds.)(2000), Environmental assessment in developing and transitional countries. John Wiley & Sons Ltd.
- Maiti, R.K. (2016) Modern Approaches to Fluvial Geomorphology, Primus Books.
- Maity S.K. and Maiti, R.K. (2018) Sedimentation in the Rupnarayan River, Vol 1, Hydrodynamic Processes under Tidal System, Springer.
- Monitoring (A case study on western part of West Bengal, India), LAMBERT Academic Publication,Germany
- Morisawa, M. (1985) Rivers, Longman, London.
- Paul A. (2002) Coastal Geomorphology and Environment---------- acb Publication, Kolkata.
- Selby, R.C. (1976), An Introduction to Sedimentology, Academic Press, London
- Shit, P.K. and Maiti, R.K. (2012), Rill Gully Erosion in Badland Topography – Field Measurement and

- Shit, P.K. and Maiti, R.K. (2013), Management techniques of Rill-Gully Erossion in Badland Topography(Experimental Research at Laboratory, Plot and Catchments Scale), LAMBERT Academic Publication,German

PAPER – GEOE552B0 (DSE 8): URBAN GEOGRAPHY AND REGIONAL PLANNING

- Bhat, L.S. (1973): Regional Planning in India, Statistical Pub. Society. Chand, M. and Puri, V.K. (1988): Regional Planning in India, Vikas, New Delhi
- Catanese (2014). Urban Planning. McGrow Hill
- Chandana, R.C. (2000): Regional Planning and Development, Kalyani Publishers
- Das Amiya Kumar (2007). Urban Planning in India. Rawat
- Faira Arthur B. Gallion (2003).The Urban pattern: City planning and Design, CBS Publication
- Glasson, J. (1974): An Introduction to Regional Planning, Hutchinson, London
- Greed, C (2000): Introducing Planning, Athlone Press, London
- Hall, P. (174): Urban and Regional Planning, Penguin, London
- Hiraskar,G.K. (2012). Fundamentals of Town Planning. DhanpatRai Publication
- Jane Jacob (1992). The Death and Life of Great American Cities. Vintage Publication
- KulshresthaS.K. (2012). Urban and regional Planning in India: A handbook for Professional Practice. SagePublication
- Mishra, R.P. (1969): Regional Planning, Concept, Techniques, Policies, The University of Mysore Press.
- Mitra, A. (1971): Levels of Regional Development India, Census of India. Tim, Hall (2006): Urban Geography, Routledge
- Rao,P. (2009). Urban Planning: Theory and Practice, CBS Publication
- Roy,G.L and Mondal, S. (1993): Gram Panchayat Organization: Effective Management for RuralDevelopment
- Sanyal, B. M (2001): Decentralized Planning- Themes and Issues, Concept. Tim, Hall (2006): Urban Geography, Routledge

PAPER – GEOE552C0 (DSE 8): APPLIED REMOTE SENSING AND GIS

- Campbell, J .B. (1996): Introduction to Remote Sensing, 2nd edition, Taylor & Francis, London: 622p.
- Castleman, K.R. (1979): Digital Image Processing. Prentice Hall Inc, New Jersey.
- Chaisman, N. 1992: Exploring Geographical Information Systems, John Wiley and Sons Inc., New York:198p.
- Cracknelll, A.P. and Hayes, L.W.B. (1991): Introduction to Remote Sensing, Taylor and Francis,
- Curran, P.J. (1988): Principles of Remote Sensing, ELBS Edn. Longman Group Ltd. UK
- Foresman,T.W.(ed) (1998): History of GIS, Prentice-Hall, Upper saddle river, NJ,
- Guha, P.K. (2003): Remote Sensing for the Beginner, Affiliated East-West Press Pvt. Ltd., New Delhi
- Joseph,, George (2003): Fundamental of Remote Sensing, University Press (India) Pvt. Ltd,
- Lillesand, T.M. and Kieffer, R.W. (2003): Remote Sensing and Image Interpretation, 5th Edition., Wiley,NY.
- Marcolongo, B. and Mantorani, F. (1997): Photogeology: Remote Sensing Application in Earth Science, Oxford
- Martin, D. (1991): Geographical Information Systems and their Socioeconomic Applications. London,Routledge.
- Masser, Ian and Blakemore, Michael (1991): Handling Geographical Information: Methodology andPotential Application, 3rd ed., Longman Scientific and Technical.
- Online source: https://archive.nptel.ac.in/courses/105/101/105101213/
- Rajan, M.S. (1995): Space today, 2nd edition, National Book Trust, New Delhi, 344p.
- Robert A. Schowengerdt,(1997): Techniques for Image Processing and Classification in Remote Sensing, Academic Press.
- Sabins, F.F. (1997): Remote Sensing: Principles and Applications, 3rd edition, W.H. Freeman & Company,New York:
- Ulaby, F.T., Moore, R,K. and Fung, A.K. (1982): Microwave Remote Sensing Active and Passive, Volume II, Radar
- Washington. Curran, P.J. (1980): Multispectral Remote Sensing of Vegetation Amount, Progress in Physical Geography

PAPER – GEOE552D0 (DSE 8): SPATIAL ANALYSIS IN LANDSCAPE ECOLOGICAL DYNAMICS

- Bodkin, D. B. 1990. Discordant Harmonies. Oxford Univ. Press, New York. 241pp.
- Boitani, L. and T. K. Fuller. 2000. eds. Research Techniques in Animal Ecology: Controversies and consequences. Columbia University Press, New York. 442pp.

- Brown, J. H. 1995. Macroecology. Univ. Chicago Press, Chicago. 269pp.
- Changing landscapes: an ecological perspective. 1989. I.S. Zonneveld and R. T. T. Forman (eds). Springer-Verlag, New York. 286 pp.
- Cronon, W. 1983. Changes in the land: Indians, colonists, and the ecology of New England. Hill and Wang, New York. 241 pp.
- Ecological Society for Conservation Biology. Blackwell Scientific Publications, London.375pp.
- Edwards, P. J., R. M. May, and N. R. Webb. eds. 1994. Large-scale ecology and conservation biology. The 35th Symposium of the British
- Farina, A. 1998. Principles and methods in landscape ecology. Chapman and Hall, New York. 235.
- Forest island dynamics in man-dominated landscapes. 1981. R. L. Burgess and D. M. Sharpe (eds. . Ecological studies 41. SpringerVerlag, New York. 310 pp.
- Gaddis, J. L. 2002. The Landscape of History. Oxford University Press, New York, N.Y. 192 pp.
- Gilovich, T. 1991. How we know what isn't so: the fallibility of human reason in everyday life. The Free Press (div. of Macmillan, Inc. New York. 216 pp.
- Gleick, J. 1988. Chaos: making a new science. Penguin Books. 352 pp.Forman, R.T.T., and M. Godron. 1986. Landscape Ecology. John Wiley
- Harris, L. D. 1984. The fragmented forest: island biogeography theory and the preservation of biotic diversity. Univ. Chicago Press, Chicago, IL. 211 pp.
- hierarchical concept of ecosystems. Monogr. in Pop. Biol. #23.Princeton Univ. Press. 253 pp.
- Klopatek, J. M. And R. H. Gardner. eds. 1999. Landscape Ecological Analysis. Springer, New York. 400pp.
- Kuhn, T. S. 1962 (1970 ed) The structure of scientific revolutions.Univ. Chicago Press, Chicago, IL. 210 pp.
- Peak, D., and M. Frame. 1994. Chaos under control: the art and science of complexity. W. H. Freeman & Co., N. Y. 408pp.
- Pickett, S. T. A., J. Kolasa, and C. G. Jones. 1994. Ecological understanding: the nature of theory and the theory of nature.Academic Press, San Diego, CA. 206pp.
- Pickett, S.T.A., and P.S. White (eds. . 1985. The ecology of natural disturbance and patch dynamics. Academic Press, Inc. 472 pp.
- Quantitative methods in landscape ecology. 1991. M. G. Turner and R. H. Gardner (eds.) Ecological Studies 82. Springer-Verlag, New York. 536 pp.
- Szaro, R. C., and D. W. Johnson. 1966. Biodiversity in managed landscapes. Oxford University Press, Oxford. 778pp

- T. F. H. Allen, and T. W. Hoekstra. 1992. Towards a unified ecology. Columbia University Press, New York. 384pp.
- Turner, M. G., R. H. Gardner, and R. V. O'Neill. 2001. LandscapeEcology in Theory and practice. Springer, New York.401pp.
- Walters, C. 1986. Adaptive management of renewable resources.Macmillan Publ. Co., New York. 374 pp.

PAPER – GEOE552E0 (DSE 8): APPLIED HYDRO-CLIMATOLOGY

- Berrisford P, Dee D, Fielding K, Fuentes M, Kallberg P, Kobayashi S, Uppala S. 2009. The ERA-Interim Archive. ERA Rep Ser [Internet]. 1(1):1–16. http://www.ecmwf.int/publications/library/do/references/list/782009
- Dee DP, Uppala SM, Simmons AJ, Berrisford P, Poli P, Kobayashi S, Andrae U, Balmaseda MA, Balsamo G, Bauer P, et al. 2011. The ERA-Interim reanalysis: Configuration and performance of the data assimilation system. Q J R Meteorol Soc. 137(656):553–597. doi:10.1017/9781009157896.
- Harris I, Osborn TJ, Jones P, Lister D. 2020. Version 4 of the CRU TS monthly high-resolution gridded multivariate climate dataset. Sci Data. 7(1):1–18.
- https://acp.copernicus.org/articles/21/11979/2021/acp-21-11979-2021.pdf
- IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R.Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, In press,

- King MD, Tsay S-C, Platnick SE, Wang M, Liou K-N. 1997. Cloud Retrieval Algorithms for MODIS: Optical Thickness, Effective Particle Radius, and Thermodynamic Phase, MODIS Algorithm Theoretical Basis Document No. ATBD-MOD-05, MOD06 – Cloud product [Internet]. version 5(December):1–79. https://cimss.ssec.wisc.edu/dbs/China2011/Day2/Lectures/MOD06OD_Algorithm_Theoretical_Basis_Document.pdf
- Lenoble J, Remer L, Tanré D. 2010. Aerosol remote sensing. Lenoble J, Remer L, Tanré D, editors. Chichester, UK: Springer in assoc Praxis Publishing.
- R Maity, 2022 Statistical Methods in Hydrology and Hydroclimatology, Springer, https://link.springer.com/book/10.1007/978-981-16-5517-3
- Stephens GL, Kummerow CD. 2007. The remote sensing of clouds and precipitation from space: A review. J Atmos Sci. 64(11):3742–3765.
- The retrieval of vertical profile from satellite radiances, https://library.ssec.wisc.edu/research_Resources/publications/pdfs/ITSC20/smith06_ITSC20_2015.pdf

- Verma S, Rao PVN, Shaeb HBK, Seshasai MVR, PadmaKumari B. 2018. Cloud fraction retrieval using data from Indian geostationary satellites and validation. Int J Remote Sens [Internet]. 39(22):7965–7977. https://doi.org/10.1080/01431161.2018.1479792
- W.P. Menzel RAF. 2015. Cloud Top Properties and Cloud Phase Algorithm Theoretical Basis Document Collection 006 Update. (March):73.
- Young, S. A., & Vaughan, M. A. (2009). The Retrieval of Profiles of Particulate Extinction from Cloud-Aerosol Lidar Infrared Pathfinder Satellite Observations (CALIPSO) Data: Algorithm Description, Journal of Atmospheric and Oceanic Technology, 26(6), 1105-1119. Retrieved Jul 5, 2022, from https://journals.ametsoc.org/view/journals/atot/26/6/2008jtecha1221_1.xml
- Young, S. A., Vaughan, M. A., Kuehn, R. E., & Winker, D. M. (2013). The Retrieval of Profiles of Particulate Extinction from Cloud–Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) Data: Uncertainty and Error Sensitivity Analyses, Journal of Atmospheric and Oceanic Technology, 30(3), 395-428. Retrieved Jul 5, 2022, from https://journals.ametsoc.org/view/journals/atot/30/3/jtech-d-12-00046_1.xml

PAPER – GEOC553X9 (DSC 9): APPLICATION OF GEOLOGICAL & GEOMORPHIC MAPPING AND RS-GIS

GEOLOGICAL & GEOMORPHIC MAPPING:

- Alex Maltman (Author), Geological maps: An Introduction (2012) ISBN-13 -978-0442303075 Springer.
- Anson, R. W. and Ormerling, F. J. 1993: Basin Cartography, Elsevier, Applied Science Publishers. London.
- Butler.J..D. and B.C.M. Bell, Interpretation of Geological Maps (Longman Earth Science Series) (1988)
- Monkhouse F.J. and Wilkinson, H.R. 1971: Maps and Diagrams: Their Compilation and Construction, B.I. Publications Private Limited, New Delhi.
- Paul A Olver, Introduction To Geological Structures And Maps, Eighth Edition (2018), Taylor and Francis Books India Pvt. Ltd.
- Pijushkanti Saha (Author), Partha Basu (Author), Advanced Practical Geography, , Books and Allied Ltd.
- Sarkar, A. 1997 : Practical Geography: A Systematic Approach, Orient Longman Ltd., Hyderabad
- Singh, R.L. & Singh, Rana P.B.: Elements of Practical Geography. Kalyani Publishers.

RS-GIS:

- Allison, L.J., Schnapf, A.(1983): Meteorological satellites: In Colwell, R.N.(ed.) Manual of Remote
- Chaisman, N. (1992): Exploring Geographical Information Systems, John Wiley and Sons Inc., New York:198p.
- Colwell, R.N. (ed.) Manual of Remote Sensing (2nd edn). American Society of Photogrammetry, FallsChurch,

- Curran, P.J. (1988): Principles of Remote Sensing, ELBS Edn. Longman Group UK Ltd.
- George, J. (2003): Fundamental Remote Sensing, Universities Press, New Delhi. John R Jensen (2006): Remote Sensing of the Environment: An Earth Resource Perspective, Pearson Education Delhi
- Guha, P.K. (2003): Remote Sensing for the Beginner, Affiliated East-West Press Pvt. Ltd., New Delhi
- Kraak, M.J. and Ormeling, F. (2004): Cartography- Visualization of Geospatial Data; Pearson Education, Singapore.
- Lillesand, T.M. and Kiefer, R. W. (2003): Remote Sensing and Image Interpretation, 5th edition, John Wiley and Sons, New York.
- Maling, D.H. (1973): Co-ordinate systems on Map Projection; George Philip and Sons Ltd, London
- Narayan L R A (2000): Remote sensing and its applications, Universities Press Hyderabad
- Raisz, E. (1962): Principles of cartography; Mc Graw Hill, NY.
- Rajan, M.S. (1995): Space today, 2nd edition, National Book Trust, New Delhi, 344p.
- 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:
- Sensing. Campbell, J .B. (1996): Introduction to Remote Sensing, 2nd edition, Taylor & Francis, London: 622p.
- Slater, P.N. (1983): Photographic systems for remote sensing, Singapore Science Center. Slater, P.N. (1983): Photographic systems for remote sensing, Virginia
- Steers, J.A. (1965): An Introduction to Map Projections, 14th ion, University of London Press, London:

PAPER – GEOC554X9 (DSC 10): **RESEARCH PROJECT/ DISSERTATION**

- Alvi. Z. (1995): Statistical Geography: Methods and Applications, Rawat Publication, New Delhi
- Compton,R.R.(1985): Geology in the Field, John Wiley and Sons.
- Gardiner,V. and Dacombe,R.(1983):Geomorphological Field Mannual,George Allen and Unwin, London
- Ghosh,B.N.(1982): Scientific Methods and Social Research ,Starling Publishers Private Ltd. New Delhi.

- Goudie, A. (1981): Geomorphological Techniques, George Allen and Unwin, London
- John, C. D. (2002): Statistics and Data Analysis in Geology; John Wiley & Sons.
- Kothari,R.C(2004):Research Methodology,New Age International Publishers, New Delhi.
- Mahmood, A (1977): Statistical methods in Geographical studies, Rajesh Pub. New Delhi
- Mishra,H.N(1998): Research Methodology in Geography,Rawat Publication.
- 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, New Delhi
- Shama,B.A.V. et al (1983): Research Methods in Social Sciences, Chaitanya Publishing House, Allahabad.
- Sjoberg g. and Nett (2002): Methodology of Social Research, Rawat Publication
- Wang, X and Vonhofe, R.a (2007): Research Method in Urban and Regional Planning, Springer
- Young,P.V.(1960): Scientific Social Surveys and Research 3rd Ed ,Prentice Hall, New York.

PAPER - GEOC555X9 (SEC 4):

APPLICATION OF AI/ML IN GEOGRAPHY

- Courage Kamusoko (2024). Explainable Machine Learning for Geospatial Data Analysis; a data centric approach. CRC Press, Boca Raton, https://doi.org/10.1201/9781003398257
- Gareth James , Daniela Witten , Trevor Hastie , Robert Tibshirani (2021). An introduction to statistical learning; with application in R. https://www.stat.berkeley.edu/~rabbee/s154/ISLR_First_Printing.pdf
- Taweh Beysolow II (2017). Introduction to deep learning using R; a step-by-step guide to learning and implementing deep learning models using R. Apress, San Francisco, California.

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

- Canter, L.W. (1996). Environmental Impact Assessment
- Divan &Rosencranz (2001). Environmental Law and Policy in India
- Glasson, J., Therivel, R., & Chadwick, A. (2012). Introduction to Environmental Impact Assessment
- Ministry of Environment, Forests and Climate Change (MoEFCC), EIA Notification 2006
- Morgan, R.K. (2012). Environmental Impact Assessment: A Methodological Perspective
- Noble, B. (2015). Introduction to Environmental Impact Assessment
- Petts, J. (1999). Handbook of Environmental Impact Assessment
- World Bank and ADB Guidelines on EIA