ADAMAS UNIVERSITY

SCHOOL OF BASIC AND APPLIED SCIENCES

DEPARTMENT OF GEOGRAPHY

Program Name:

M.Sc. (GEOGRAPHY)

Program Code: GEO4202

Total Credit: 95

Syllabus 2025-26

(Course Structure and Syllabus modified as per the Board of Studies meeting held on 12th June 2025)

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF GEOGRAPHY

VISION OF THE UNIVERSITY

To be an internationally recognized university through excellence in interdisciplinary education, research and innovation, preparing socially responsible well-grounded individuals contributing to nation building

MISSION STATEMENTS OF THE UNIVERSITY

M.S 01: Improve employability through futuristic curriculum and progressive pedagogywith cutting-edge technology

M.S 02: Foster outcomes based education system for continuous improvement ineducation, research and all allied activities

M.S 03: Instill the notion of lifelong learning through culture of research and innovation
M.S 04: Collaborate with industries, research centers and professional bodies to stayrelevant and up-to-date

M.S 05: Inculcate ethical principles and develop understanding of environmental and social realities

CHANCELLOR / VICE CHANCELLOR

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF GEOGRAPHY

VISION OF THE SCHOOL

To be recognised globally as a provider of education in Basic and Applied Sciences, fundamental and interdisciplinary research.

MISSION STATEMENTS OF THE SCHOOL

M.S 01: Develop solutions for the challenges in sciences through value-based science education.

M.S 02: Conduct research leading to innovation in sciences.
M.S 03: Nurture students into scientifically competent professionals in the usage of modern tools.

M.S 04: Foster in students, a spirit of inquiry and collaboration to make them ready for careers in teaching, research and corporate world.

DEAN (SoBAS)

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF GEOGRAPHY

VISION OF THE DEPARTMENT

To achieve excellence for imparting quality higher education and skills in Geography that can serve to the society adopting the changing versatility of job and research opportunities

MISSION STATEMENTS OF THE DEPARTMENT

M.S 01: Create highly qualified and employable geographers by imparting quality education and research aptitude

M.S 02: Enhance the skills of geoinformatics and data analysis along with encourage for entrepreneurship, innovativeness, self-learning in an interdisciplinary domain

M.S 03: To foster professional ethics and responsibilities for the organization, society and environment

M.S 04: To promote collaborations with industries, research institutes and experts for transmitting up-to-date knowledge, training, research skills and connection with the world

HOD, Geography **DEAN (SoBAS)**

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF GEOGRAPHY

NAME OF THE PROGRAMME: M.SC GEOGRAPHY

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO 01: Break down existing environmental problems into achievable sustainable solution.

PEO 02: Leverage professional capabilities by harnessing the advanced and evolving technology.

PEO 03: Posses an effective communication skill and become a true team worker with higher sense of ethics, value.

PEO 04: Exploring new and innovative ideas for research and innovation.

HOD, Geography **DEAN (SoBAS)**

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF GEOGRAPHY

GRADUATE ATTRIBUTE / PROGRAMME OUTCOME (PO)

GA 01 / PO 01: Advanced Knowledge in Applied Geography: Demonstrate knowledge of concepts, methods, and theories designed for advanced learning of the natural world and human society, and their implications for research and societal benefits.

GA 02 / PO 02: Specialized Knowledge for Future Research: In-depth knowledge and research capabilities in, at least one particular geographic subfield.

GA 03 / PO 03: Environmental Ethics and Sustainability: Critical understanding of man-environment relationships, and aptitude towards management of environment and resources for sustainable development.

GA 04 / PO 04: Modern Research Skills for Data Analysis: Manipulate, visualize and analyse maps and data for a variety of purposes through geo-computation, cartography, programming, remote sensing and GIS techniques.

GA 05 / PO 05: Handling Modern Instruments and Field Project: Efficient in conducting field projects through designing field plans, data collection with various modern instruments and questionnaire surveys, and project analysis.

GA 06 / PO 06: Advanced Writing Skills: Capable of writing and design good quality of articles, reports, research papers and thesis.

GA 07 / PO 07: Development of Communication Skills and Leaderships: Develop quality for lectures and research presentations, good communication, leadership, work in groups, and other extracurricular activities.

GA 08 / PO 08: Professional Development: Capable of competing in various competitive examinations for research (NET/SLET) and government jobs, and efficient in making a career as a research project scientist and GIS analyst.

GA 09 / PO 09: Ethics: Demonstrate applications of ethical values in academic discourses and professional practises.

GA 10 / PO 10: Life-long Learning: Recognize the need for, and acquire the ability to engage in independent and life-long learning in the broadest context of social, environmental and technological changes.

HOD, Geography **DEAN (SoBAS)**

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF GEOGRAPHY

PROGRAMME SPECIFIC OUTCOME (PSO)

PSO 01: Critical Thinking: Critical thinking of processes and phenomena of the natural world and human society, and their application for environmental protection and sustainable development.

PSO 02: Specialized knowledge and Research: Mastering in specialization by understanding theoretical concepts, and conducting independent research in their chosen field.

PSO 03: Modern Skill for Data Analysis: Expertise in modern skills for data analysis through geo computation, geo-visualization and geoinformatics to provide solutions for social and environmental problems, planning and management.

PSO 04: Professional Career Development: Make a good competitor to obtain better job opportunities in Competitive Examinations, Researcher, Teacher/Professor, Government employer and GIS specialist.

HOD, Geography **DEAN (SoBAS)**

School of Basic and Applied Sciences
Department of Geography
M.Sc. (Geography), Course Structure

1st Year								
SEMESTER I								
Sl. No.	**Type of Course**	**Code**	**Title of the Course**	**Contact Hours Per Week**				**Total Credit**
				L	**T**	**P**	**C**	
1	CC	GEO451	Geotectonics and Geomorphology	4	0	0	4	
2	CC	GEO452	Population and Settlement	4	0	0	4	
3	CC	GEO453	Advanced Cartography and Surveying Lab	0	0	6	4	
4	DSE/ MDE	 GEO454 GEO455 GEO456	Discipline Specific Elective courses- 1. Soil and Biogeography 2. Regional Geography 3. Geography of Economic Behaviour SAWYAM MOOC courses (Any courses aligning with the themes of specified DSE courses, subject to availability in the portal within the stipulated time frame)	4	0	0	4	
5	RM	GEO457	Research Methodology	3	0	2	4	
6	SEC (Hands-On Training)	GEO458	Basic Geoinformatics	0	0	3	2	
7	SEC		Career Development Course I (Soft Skill / Soft Skill and Aptitude Course)	1	0	0	1	
8	AEC		Foreign Language	2	0	0	2	
			Semester Credits				**25**	
SEMESTER II								
1	CC	GEO459	Climatology	4	0	0	4	
2	CC	GEO460	Philosophy of Geography	4	0	0	4	
3	CC	GEO461	Geo-statistics Lab	0	0	6	4	

4	DSE	GEO462 GEO463 GEO464	Discipline Specific Elective courses- 1. Hydrology and Oceanography 2. Political Geography and International Relations 3. Social-Cultural Geography SAWYAM MOOC courses (Any courses aligning with the themes of specified DSE courses, subject to availability in the portal within the stipulated time frame)	4	0	0	4	
5	MDE		**MDE Pool:** NA **SAWYAM MOOC courses** (Any courses aligning with the themes of specified MDE courses, subject to availability in the portal within the stipulated time frame)	4	0	0	4	
6	SEC (Hands-On Training)	GEO465	Advanced Geoinformatics	0	0	3	2	
7	SEC		Career Development Course I (Soft Skill / Soft Skill and Aptitude Course)	1	0	0	1	
8	AEC		Foreign Language	2	0	0	2	
						Semester Credits	**25**	
Exit option with Post-Graduate Diploma after the first year or two semesters, with the completion of courses equivalent to 50 credits								

2nd Year								
SEMESTER III								
Sr. No	**Type of Course**	**Code**	**Title of the Course**	**Contact Hours Per Week**				**Remarks**
				L	**T**	**P**	**C**	
1	CC	GEO500	Geography of Environment, Hazards & Disaster	4	0	0	4	
2	CC	GEO501	Geo-spatial Analysis and its Applications Lab	0	0	6	4	
3	CC	GEO502	Geocomputation and Geovisualisation Lab	0	0	3	2	
4	DSE	GEO503 GEO504 GEO505 GEO506 GEO507	**Bucket List:** 1. Environmental Geography I 2. Applied Geomorphology and Hazard I 3. Urban and Regional Planning I 4. Hydro-meteorology I 5. Remote Sensing and GIS I	4	0	0	4	
5	DSE	GEO508 GEO509 GEO510 GEO511 GEO512	**Bucket List:** 1. Environmental Geography I Lab 2. Applied Geomorphology and Hazard I Lab 3. Urban and Regional Planning I Lab 4. Hydro-meteorology I Lab 5. Remote Sensing and GIS I Lab	0	0	3	2	
6	INT	GEO513	Internship				2	
7	Project	GEO514	Dissertation I				4	
8	SEC		Career Development Course I (Soft Skill / Soft Skill and Aptitude Course)	1	0	0	1	
						Semester Credits	**23**	
SEMESTER IV								
1	CC	GEO515	Advanced Quantitative Techniques Lab	0	0	6	4	
2	DSE	GEO516 GEO517 GEO518	**Bucket List:** 1. Environmental Geography II 2. Applied Geomorphology and Hazard II 3. Urban and Regional Planning II	4	0	0	4	

		GEO519 GEO520	4. Hydro-meteorology II 5. Remote Sensing and GIS II					
3	DSE	GEO521 GEO522 GEO523 GEO524 GEO525	**Bucket List:** 1. Environmental Geography II Lab 2. Applied Geomorphology and Hazard II Lab 3. Urban and Regional Planning II Lab 4. Hydro-meteorology II Lab 5. Remote Sensing and GIS II Lab	0	0	3	2	
4	ED	GEO526	Entrepreneurship Course				2	
5	Project	GEO527	Dissertation II				6	
6	Project	GEO528	Field Project				4	
Semester Credits							**22**	
Total Credits							**45**	

Total credit for 2-year M.Sc. (Geography) = 95

SEMESTER I

GEO451	Geotectonics and Geomorphology	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	UG level Geomorphological knowledge				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. **Explain** the origin and evolution of the universe and Earth's geotectonic mechanisms.
CO2. **Analyze** plate tectonic theory to interpret geological processes like orogenesis, volcanism, and earthquakes.
CO3. **Apply** geomorphological concepts to assess landform evolution across various temporal and spatial scales.
CO4. **Examine** river hydraulics and channel morphology to understand sediment dynamics and network development.
CO5. **Evaluate** geomorphological hazards, including their mechanisms, causes, and potential impacts on landscapes.
CO6. **Create** sustainable strategies to mitigate geomorphological hazards using scientific principles and hazard assessments.

Course Content

Unit I: Concepts in Geotectonics (15 Hours)
Origin and the evolution of the Universe; Origin of earth magnetic field and paleomagnetism; Mechanism of Plate dynamics; Application of plate tectonics theory in explaining orogenesis, volcanism, earthquake; Neo-tectonics and its worldwide evidences.

Unit II: Concepts in Geomorphology (15 Hours)
Spatial scale, temporal scale and related concepts: Systems, feedback, equilibrium and threshold, Morphogenetic regions; Models of slope evolution; Processes of landform evolution: Fluvial, Glacial, Periglacial, and Coastal. Impact of Pleistocene on landform evolution, Concept of planation.

Unit III: Rivers Hydraulics and Channel Morphology (15 Hours)
River hydraulics: flow and energy; Hydraulic geometry of streams, Catchment processes and fluvial processes; Factors regulating entrainment, transportation and deposition of sediments; Adjustment of channel forms and patterns to morphodynamic variables, Channel initiation and network development.

Unit IV: Geomorphological Hazards (15 Hours)
Geomorphological resources and hazards, classification of geomorphological hazards; Mechanism, causes and assessment of: Fluvial hazards: river bank erosion and flood; hillslope

hazards: landslide and soil erosion; Coastal hazards: coastal erosion, sea-level change and tsunami.

Recommended Readings:

1. Bloom, A.L. 1992: Geomorphology- Systematic Analysis of Late Cenozoic Landforms, Prentice Hall India, New Delhi.
2. Chorley, R.J. 1969: Introduction to Fluvial Processes, Methuen, London
3. Chorley, R.J., Schumm, S. A. and Sugden, D.E. 1984: Geomorphology, Methuen, London
4. Dayal, P. 1996: Textbook of Geomorphology, Shukla Book Depot, Patna.
5. Husain Majid (2002), Fundamenatls of Physical Geography, Second Edition, Rawat Publications, Jaipur and New Delhi.
6. K. Siddartha – Earth Dynamic Surface (Transworld Media & Communications – Publication – Patna, 1994)
7. Kale, V. and Gupta, A. 2001: Introduction to Geomorphology, Orient Longman, Kolkata
8. McCullagh, P. 1978: Modern Concepts in Geomorphology, Oxford University Press, Oxford.
9. Ollier, C.D. 1975: Weathering, Longman, London
10. Ollier, C.D. 1981: Tectonics and Landforms, Longman, London
11. Selby, M.J., (2005), Earth's Changing Surface, Indian Edition, OUP
12. Singh Savindra (1993), Physical Geography,PrayagPustakBhawan, Allahabad.
13. Small, R.J. 1978: The Study of Landforms, Cambridge University Press, Cambridge

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	2	2	1	1	2	1	1	1	3	2	2	2	3
CO 2	3	3	2	2	1	3	2	1	2	3	3	3	3	2
CO 3	3	3	3	2	2	3	2	1	2	2	2	2	2	3
CO 4	2	3	3	2	2	3	3	2	2	3	3	3	3	3
CO 5	2	2	3	2	3	3	2	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO452	Population and Settlement	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	Undergraduate level knowledge of Population Studies, Settlement Geography and Urban Geography				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

- **CO1.** **Clarify** trends in population growth with classical and neo-classical theories.
- **CO2.** **Analyze** determinants of migration and its socio-economic impacts.
- **CO3.** **Describe** settlement typologies and hierarchy with a focus on urbanization processes.
- **CO4.** **Relate** urban infrastructure challenges with governance and planning strategies.
- **CO5.** **Evaluate** urban housing policies and sustainable transport systems.
- **CO6.** **Develop** solutions to mitigate the impacts of subaltern urbanization.

Course Content

Unit I: Population Geography: (15 hours)

Evolution of Population Geography-Contemporary trends; Relationship of population geography with other disciplines, Theories of Population Growth: Pre Malthusian views, Malthus theory, Socialist and Marxist writings on Population Growth– Concept and Calculation of Fertility and Mortality Rate; Theories of Fertility; Population Projection, Construction of Life Table

Unit II: Migration, Mobility and Displacement: (15 hours)

Factors, processes and typology – Contemporary trends in developed and developing countries – Rural and urban dimensions; Impact of Migration on population change and economy in source area and destination, Theories of Migration, Population policies; Population as social capital-Status of developed and developing countries, Population and Vulnerability: Displacement – Diaspora and Identity Crisis.

Unit III: Settlement: (15 hours)

Concept of settlement: Rural and Urban, Census categories of settlement; Characteristics of rural settlement, Dispersion and Segregation of rural settlement; Rural Service Centers and Hierarchy, Concepts of Urban, Urbanism and Urbanization; Concept of Conurbation, Metropolitan city, Megalopolis and Ecumenopolis; Urban society and Urban Form - Colonial City, Industrial City, Post Industrial City, Global City, Morphology of Towns: Classical models and Non-classical models. Theories of Spacing of urban settlement; Urban Hierarchy;

Unit IV: Urban Infrastructure: (15 hours)

Concept of Urban Re-development, Urban renewal – Gentrification, Urban policy and planning-Urban Governance; Urban Housing policies and problems with special reference to Slums; Subaltern urbanization, Water Supply, Sanitation and sewerage, Solid waste management, Urban Transport: New models of public transport

Recommended Readings:

1. Carter, H.1975: The Study of Urban Geography, Edward Arnold, London
2. G. Dickinson, R. E. 1964: City and Region

3. Ghosh, S. 1998: Settlement Geography, Orient Longman Ltd., Kolkata
4. Hudson, F. S. 1976: Geography of Settlement
5. Johnson, J.H. 1977: Urban Geography- An Introductory Analysis, Pergamon press, Oxford
6. Mandal, R.B. 2001: Introduction to Rural Settlements, Concept Publishing Company, New Delhi
7. Misra, H.N. 1987: Rural Georaphy, Vol. IX, Contributions to Indian Geography, Heritage Publishers,New Delhi.
8. Ramachandran R., 1989: Urbanisation and Urban Systems of India, Oxford University
9. Singh R.L. & K.N. Singh, 1975: Readings in Rural Settlement Geography, NGSI Varanasi
10. Agarwala, S.N. 1985: India's Population Problems, Tata McGraw hill, New Delhi
11. Chandna, R.C. 1986: A Geography of Population, Kalyani Publishers, New Delhi
12. Clarke, J. I. 1971: Population Geography and the Developing Countries, Pergamon Press, Oxford
13. Clarke, J. I. 1972 Population Geography, Pergamon Press, Oxford
14. Hassan, M.H. 2005: Population Geography, Rawat Publications, New Delhi
15. Mamoria, C.B. India's Population Problem, KitabMahal New Delhi, 1981.
16. Mitra, A. 1978: India's Population: Aspects of Quality and Control Vol I & II. Abhiman Publications, New Delhi
17. Trewartha, G.T. 1969: A Geography of Population- World Patterns, John Wiley, New York.
18. Zacharia, E. and Sinha, V.C., 1986 : Elements of Demography, Allied publishers Pvt Ltd, New Delhi
19. Zelinsky, W. 1966: A Prologue to Population Geography, Prentice Hall India, New Delhi.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	2	2	1	2	2	1	2	3	3	3	3	2
CO 2	3	3	3	2	1	2	2	1	2	3	3	2	3	3
CO 3	3	3	3	3	2	2	2	1	2	3	3	3	3	3
CO 4	2	2	3	3	2	3	3	2	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO453	Advanced Cartography and Surveying Lab	L	T	P	C
		0	0	6	4
Pre-requisites/Exposure	UG level Cartography, Surveying knowledge				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. Demonstrate advanced cartographic techniques for map design and production.
CO2. Apply field surveying methods using modern instruments like Total Station and GPS.
CO3. Analyze spatial data to create accurate topographical and thematic maps.
CO4. Illustrate geographic features using advanced cartographic visualization tools.
CO5. Evaluate data accuracy and precision in field surveys and cartographic projects.
CO6. Present maps and survey findings effectively through professional cartographic outputs.

Course Content

Unit I: Basics of Map Projection (45 hours)

Cartography – scope, content, principles and development, Basic concepts — parallels & meridians, latitudes & longitudes, great circle, map projection, scale factor, deformations, orthodrome, loxodrome and geodesic (simple problems of distance and azimuth); co-ordinate system and location on globe and 2D planes, Drawing Graticules, Scale Variation and Scale Error, Mapping Countries, Continents, World with Geographical Features on –

A. Planer (Polar Zenithal Orthographic and Equal Area) Projections
B. Conical (Simple Conic – I, Bonne's, Polyconic, Sinusoidal, Simple Conic - II) Projections
C. Cylindrical (Equal-area and Orthomorphic) Projections
D. Conventional (Mollweide) Projections

Unit II: Basic Surveying (15 Hours)

Nature and Principles of Surveying; Types of Surveying, Basic concepts of Traversing, Triangulation, Trilateration, Levelling and Contouring (including solutions of related problems) with –

A. Prismatic Compass,
B. Dumpy Level
C. Preparing ground plan and determining height and distance of an object using Theodolite,

Unit III: Modern Surveying Solutions (15 Hours)

Surveying methods and mathematical implication of Total station, (Triangulation and Traversing method) surveying; Total Station Survey in field, downloading, processing and generation of survey plots using software.

Unit IV: GPS and DGPS Surveying (15 Hours)

Global Positioning System (GPS) survey: Handheld GPS Operation - feature collection, data

transfer, area calculation, data processing and generation of survey plots; DGPS Survey - Components, types, DGPS instrument and its accessories, surveying and data capture, Error Corrections, Integration with GIS.

Recommended Readings:

1. Hussain. S.K. AND Nagaraj. M.S. 1992, Text Book of Surveying. S. Chand & Co. Ltd. New Delhi.
2. Ishtiaque, M. 1989: Practical Geography, Heritage Publishers, New Delhi.
3. Kanetkar. R.P. and Kulkarni. S.V. 1988, Surveying and Levelling, Part-I Pune Vaidyarthi Griha Prakashani, Pune.
4. Kanetkar, T.P., and S.V. Kulkarni. *Surveying and Levelling, Vol. 1 &2*. Pune: Pune Vidyarthi Griha Prakashan, 2010.
5. Punmia, B.C., Ashok Kumar Jain, and Arun Kumar Jain. *Surveying: Principles and Applications*. New Delhi: Laxmi Publications, 2008.
6. Subramanian, R. *Surveying and Levelling*. Chennai: Oxford University Press, 2008.
7. Basak, N.N. *Advanced Surveying*. New Delhi: McGraw-Hill Education, 2010.
8. Punmia, Dr. B.C. *Surveying (Vol. 1, 2, 3)*. New Delhi: Laxmi Publications, 2017.
9. Chandra, A.M., and Vineet Kumar. *Modern Surveying Techniques*. New Delhi: CRC Press, 2023.
10. *Tiberius et.al. (2022) : Emerging Trends in Surveying and Mapping Technologies* - https://textbooks.open.tudelft.nl/textbooks/catalog/download/46/150/382?inline=1
11. Gopi. et. al. (2023): *Advanced Surveying*. New Delhi: Pearson Education.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	3	3	2	3	2	1	2	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO454	Soil and Biogeography	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	Graduate level Soil and Biogeography knowledge				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. Discuss the soil formation processes and their chemical and physical properties.
CO2. Illustrate the biogeographical theories that influence species distribution.
CO3. Explain the processes of extinction, biological invasions, and animal dispersal.
CO4. Apply concepts of ecological and biotic resources to environmental challenges.
CO5. Evaluate conservation strategies for plant and animal species.
CO6. Design soil and biogeographical research methods to study environmental systems.

Course Content

Unit I: Soil Geography (15 Hours)

Soil as a component of Biosphere; Concept of land and soil; Factors or soil formation, Soil profile, soil properties, Plant-water-soil relationship, Bio-functions of Soil; Soil organic matter, Soil organisms and Micro-organisms and their relation with soil fertility, Soil mineralogy and Soil nutrients; Role of physico-chemical properties in soil fertility and productivity, Soil degradation and pollution: causes, processes and consequences; Preventive, ameliorative and conservation measures.

Unit II: Plant Geography (15 Hours)

Plant ecology: habitat factors and plant responses to environment: adaptation, and climax: domestication of plants, Phyto-geographical regions; Concept of plant species, family and genera; taxonomy, Consequences of deforestation and exploitation of targeted species; Forest conservation, Social forestry and Participatory Management of Forest, Concept of degeneration and regeneration of plants.

Unit III: Zoo Geography (15 Hours)

Theory of evolution of species and its critics, Dispersal of animals in different geological periods, Dispersal and migration of animals; means and barriers; Zoo-geographical regions of the world, Principles of animal ecology; Wild life management; Relevance of sanctuaries with special reference to India.

Unit IV: Ecosystem and Ecology (15 Hours)

Principles of physical and human ecology; Ecosystem models, Concepts of biological desert and deep ecology; Forms and functions of forest and marine ecosystems, International Biological Programme, Man and Biosphere Programme, Biodiversity conservation with special reference to humid tropics.

Recommended Readings:

1. Anderson: Ecology for Environmental Science.
2. Biswas, T.D. and Mukherjee, S. K. 1987: Text book of Soil Science, Tata McGraw Hill, New Delhi.
3. Buckman, H.R. and Brady, N.C. 1974: Nature and Properties of Soil, McMillan, New York.

4. Bunting, A. 1965: Geography of Soil, Hutchinson, London.
5. Chapman, J.L. and Reiss, M.J. 1992: Ecology Principles and Applications, Cambridge University Press, Cambridge.
6. Daji, J.A., Kadam, J.R. and Patil, N.D. 1996: A Textbook of Soil Science, Media Promoters and
7. Publishers Pvt Ltd, Mumbai.
8. Joffe, J. S. 1965: ABC of Soil.
9. Kormondy, E. J. 1991: Concepts of Ecology.
10. Nebel, J.B. 1981: Environmental Science, Prentice Hall, New York.
11. Odum, F.P. 1971: Fundamentals of Ecology, W.B. Sanders, Philadelphia.
12. Robinson, H. 1982: Biogeography.
13. Jenny. 1941: Factors of soil formation. Dover Publication.
14. Brady, N.C., Weil, R.R. 1999: The nature and properties of soils. Prentice Hall, Londan

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	2	2	3	3	2	1	2	3	3	3	3	2
CO 2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO455	Regional Geography	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	Undergraduate level Geography knowledge				
Co-requisites					

Course Outcomes

On completion of this course, the students will be able to:

CO1. Develop a spatial approach toward analyzing geographic elements in regions.
CO2. Establish linkages between physical and social aspects of human-environment interaction.
CO3. Assess distribution patterns of geographic phenomena on global, national, and regional levels.
CO4. Analyze the regional geography of India and West Bengal, focusing on diversity.
CO5. Evaluate techniques of regionalization and their applications in planning.
CO6. Apply regional concepts to address developmental and resource-based issues.

Course Content

Unit I: Introduction to Regions and Regional Geography (15 hours)
Nature and scope of regional geography; Approaches to regional study, Regions and regionalization - methods and techniques of regionalization, Concept and approaches of physical regions, Socio-cultural regions and planning regions.

Unit II: Physical Entities of Region (15 hours)
Geological Structure, Physiography and relief features, Drainage system, Soil, Natural vegetation, Climatic Classifications of the World, India and West Bengal

Unit III: Economic Entities of Region (15 hours)
Major resource base and their distribution, Agricultural patterns and problems, Industrial development and problems, Growth of Tertiary sector, Knowledge economy and its prospect**,** Trend of economic planning, Regional disparity in the World, India and West Bengal

Unit IV: Socio-cultural entities of region (15 hours)
Components of delineation of social regions, Major Cultural Hearths of the world, Ethnicity as a component of regionalization, Language as a component of regionalization, Concept of regional Development, Regional backwardness and conflict in the World, India and West Bengal.

Recommended Readings:

1. Critchfield, H.J. 1966: General Climatology, Prentice Hall, New York.
2. Das, P.K., 1988: The Monsoons, National Book Trust, India, New Delhi.
3. Barry, R.G. and Chorley, R.J. 1985: Atmosphere, Weather and Climate, Methuen,London.
4. Kormondy, E. J. 1991: Concepts of Ecology.
5. Nebel, J.B. 1981: Environmental Science, Prentice Hall, New York.
6. Odum, F.P. 1971: Fundamentals of Ecology, W.B. Sanders, Philadelphia.
7. Robinson, H. 1982: Biogeography.
8. Carter, H.1975: The Study of Urban Geography, Edward Arnold, London

9. Daniel, P. 2002: Geography of Settlement, RawatPubls., Jaipur & New Delhi.
10. Mandal, R.B. 2001: Introduction to Rural Settlements, Concept Publishing Company, New Delhi
11. Misra, H.N. (1987) Rural Georaphy, Vol. IX, Contributions to Indian Geography, Heritage Publishers, New Delhi.
12. Trewartha, G.T. 1969: A Geography of Population- World Patterns, John Wiley, New York.
13. Zacharia, E. and Sinha, V.C., 1986: Elements of Demography, Allied publishers Pvt Ltd, New Delhi
14. Zelinsky, W. 1966: A Prologue to Population Geography, Prentice Hall India, New Delhi
15. Clarke, J. I. 1971: Population Geography and the Developing Countries, Pergamon Press, Oxford
16. Clarke, J. I. 1972 Population Geography, Pergamon Press, Oxford
17. Hassan, M.H. 2005: Population Geography, Rawat Publications, New Delhi
18. Ahuja R. 2001: Social problem in India Rawat Publication
19. Claval P.2002: An Introduction to regional geography, Blackwell Publishers
20. Sen P.K. & Prasad N. 2002 An introduction to Geomorphology of India, Allied publishers Pvt. Ltd.
21. Singh R.L. (ed) 1971 India: a regional geography NGSI
22. Spate O.H.K. &Learmonth A.T.A.1967:India& Pakistan Munsiram Monoharlal pub. Pvt. Ltd
23. Mishra, R.P (ed): Regional Planning- Concepts, Tools, Techniques and case studies.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	2	2	2	1	2	1	1	2	3	2	2	3	2
CO 2	3	3	3	2	1	2	2	1	2	3	3	2	3	3
CO 3	3	3	3	3	2	3	2	1	2	3	3	3	3	3
CO 4	2	2	3	3	2	3	3	2	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO456	Geography of Economic Behavior	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	Undergraduate level Geography knowledge				
Co-requisites					

Course Outcomes

On completion of this course, the students will be able to:

CO1. **Understand** economic systems, behavior, and decision-making processes.
CO2. **Analyze** the operational environment and the theories of economic geography.
CO3. **Evaluate** the factors that influence agricultural and manufacturing systems.
CO4. **Assess** the location and development of tertiary systems, including trade and transportation.
CO5. **Apply** economic models to understand the spatial organization of services and industries.
CO6. **Develop** strategies for sustainable economic development based on environmental and social considerations.

Course Content

Unit I: Toward Geography of Economic Behaviour – Some Basic Concepts (15 Hours)
A new geography of Economic Behaviour, Some economic terms: economy, consumer, economic organization, economic behaviour, human behaviour and decision making; the domain of space and time, The economic system: system, equilibrium, feedback, entropy and negentropy, cybernetics. Knowledge economy, the corporate society.

Unit II: Environmental and Economic Milieux – An Overview (15 Hours)
The phenomenal environment and the behavioural environment, the operational milieu and its components; Models of Natural and Human Milieux I – Functional Model (Zimmerman), Decision Model (Kirk), and Behavioural Model (Pred), Models of Natural and Human Milieux II – System Model (Brookfield)

Unit III: Agricultural and Manufacturing Systems (15 Hours)
Economics of agriculture; Constraints for agriculture;, Classical model of agricultural behaviour; Von Thunen's Model (with modifications); Neo classical agricultural behavior; Nature of manufacturing system; economic structure, entrepreneurial behaviour, systems and Organizations, Comparison in between traditional and modern approaches to industrial locations and their applications;

Unit IV: The Tertiary Systems (15 Hours)
Nature, location of services and trade of tertiary system and sub-system; components of tertiary subsystem; the transportation system, Central place theory (Christaller) as a Classical study of mechanics of the tertiary sub system with modifications and extensions; Economic regions; Social Marketing of Green Products; Malfunctions of the System - the three worlds; Population and resources; Economy and ecology; Sustainable development.

Recommended Readings:
1. Hurst. M.E.E. (1972): Geography of Economic Behaviour – An Introduction, Duxbury

Press,California.
2. Leyshon, A. and et.,al. (2011): The SAGE Handbook of Economic Geography, Sage, Los Angeles.
3. Aoyama, Y., Murphy, J.T. and Hanson, S. (2011): Key Concepts in Human Geography, Sage, LosAngeles.
4. Berry, B.J.L., Conklin, E.C. and Ray, M. D. (1976): The Geography of Economic Systems, PrenticeHall, New Jersey.
5. Alexandersson, C, 1971: Geography of Manufacturing, Prentice Hall India, New Delhi.
6. Hartshorn, T.A. and Alexander, J.W. 1988: Economic Geography, Prentice Hall India, New Delhi.
7. Leong. G.C. and Morgan, G.C. 1975: Human and Economic Geography, Oxford University Press,Hong Kong

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	2	2	3	3	2	2	2	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 3	3	3	3	3	2	3	3	2	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO457	Research Methodology	L	T	P	C
		3	0	2	4
Pre-requisites/Exposure					
Co-requisites					

Course Outcomes

On completion of this course, the students will be able to:

- **CO1. Explain** the principles of research design and the various types of research methods.
- **CO2. Formulate** research problems and hypotheses.
- **CO3. Design** an appropriate methodology for data collection and analysis.
- **CO4. Analyze** data using quantitative and qualitative techniques.
- **CO5. Interpret** research findings and draw conclusions.
- **CO6. Present** research outcomes through academic writing and presentations.

Course Content

Unit I: Fundamentals of Research (15 Hours)
Meaning of Research, Nature, and objectives of the research; Research Types: descriptive-analytical, pure-applied, conceptual-empirical, qualitative-quantitative; Motivations in Research; Writing corporate and scientific research reports

Unit II: Research Process (15 Hours)
Identification of research gap; Selection of research objectives; Literature Review: Conducting literature survey- searching literature, reviewing selected literature, developing theoretical and conceptual frameworks, Reporting literature review; Citation methods

Unit III: Data Collection Methods (20 Hours)
Preparation of questionnaire, Interview: Focus group, participant observation; Hypothesis/Research Question; Sampling- Concept and principles; Probability and Non-Probability sampling- types and criteria for selection; Sample size calculation and developing sampling Frames

Unit IV: Reading and Writing a Scientific Research Paper (25 Hours)
Writing a proposal of research (~2 pages) which will include (1) identifying the research problem; (2) providing background information; (3) listing objectives; and (4) describing data and methods. Developing and implementing an idea related to a scientific research paper (Literature review based)

Recommended Readings:

1. Best and Kahn, Research Methodology, PHI Limited.
2. Kothari, C.R. Research Methodology (Methods and Techniques), New Age Publisher.
3. Kerlinger, Foundation of Research.

4. Fundamentals of modern statistical methods by Rand R. Wilcox.
5. Power Analysis for Experimental Research A Practical Guide for the Biological, Medical and Social Sciences by R. Barker Bausell, Yi-Fang Li Cambridge University Press.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	2	3	2	2	2	2	3	3	3	3	3	3
CO 2	3	3	3	3	2	3	2	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO458	Basic Geoinformatics	L	T	P	C
		0	0	3	2
Pre-requisites/Exposure	Undergraduate-level knowledge of GIS and RS				
Co-requisites	Basic knowledge of computer skills				

Course Outcomes

On completion of this course, the students will be able to

CO1. **Demonstrate** the use of GIS and remote sensing software for data analysis.
CO2. **Apply** geospatial data visualization techniques for geographical representation.
CO3. **Collect** and process spatial data from various sources.
CO4. **Analyze** geographical patterns using GIS tools and spatial statistics.
CO5. **Interpret** satellite images and maps for geographic decision-making.
CO6. **Present** the analysis and results through maps and reports.

Course Content

Unit I: Introduction to satellite images (10 Hours)
Spectral bands, band combination, image registration (ground control point and image to image); Image interpretation keys using FCC, Interpretation of physical and cultural features.

Unit II: Digital Image Processing (15 Hours)
Pre-processing techniques: Geometric and atmospheric correction, Image enhancement and filtering; Multi-band enhancement techniques—band Ratios, indices, spatial filtering; resolution merge techniques; Image classification: supervised and unsupervised; multi-date data analysis and change detection processes, accuracy assessment.

Unit III: Introduction to Geographic Information System (10 Hours)
Creation of vector database: point, line, and polygon, geopackage creation and attribute joining; measurement tools, changing projection, Thematic mapping: map composition and representation.

Unit IV: Introduction to GPS (10 Hours)
Principles of Global Positioning System (GPS); Collection of GPS data and mapping, Introduction to Geoportal Applications – Google Earth.

Laboratory Notebook and Viva Voce

Recommended Readings:

1. Bhatta B., 2011: Remote Sensing and GIS, Oxford Publisher.

2. Campbell J. B., 2007: Introduction to Remote Sensing, Guildford Press.
3. Jensen J. R., 2004: Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall.
4. Joseph, G. 2005: Fundamentals of Remote Sensing, United Press India.
5. Lillesand T. M., Kiefer R. W. and Chipman J. W., 2004: Remote Sensing and Image Interpretation, Wiley. (Wiley Student Edition).
6. Nag P. and Kudra, M., 1998: Digital Remote Sensing, Concept, New Delhi.
7. Rees W. G., 2001: Physical Principles of Remote Sensing, Cambridge University Press.
8. Singh R. B. and Murai S., 1998: Space-informatics for Sustainable Development, Oxford and IBH Pub.
9. Wolf P. R. and Dewitt B. A., 2000: Elements of Photogrammetry: With Applications in GIS, McGraw-Hill.
10. Wolf P. R. and Dewitt B. A., 2000: Elements of Photogrammetry: With Applications in GIS, McGraw-Hill.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	3	3	2	3	2	1	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

SEMESTER: II

GEO459	**Climatology**	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	Undergraduate level knowledge of Climatology/Meteorology/Atmospheric Science				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. **Explain** atmospheric thermodynamics, stability, and precipitation mechanisms.
CO2. **Analyze** tropical climates and atmospheric circulation systems, including the Asian monsoon.
CO3. Evaluate the impacts of climate change using paleoclimatology and environmental systems.
CO4. Apply climatology in weather forecasting, agro-climatology, and urban heat island studies.
CO5. **Assess** the effectiveness of climate models and predictions for global trends.
CO6. **Formulate** strategies to address climate-related health and urban challenges.

Course Content

Unit I: Understanding the Atmosphere: (15 hours)

The thermodynamics of the atmosphere - Ideal Gas Law, Gas Constant, Hydrostatic equilibrium, Hydrostatic equation, variation of pressure with height; Role of heat and moisture in the atmosphere –laws of thermodynamics, heat and energy transfer in the atmosphere - diabetic processes and adiabatic processes, stabilities and instabilities, Cloud and Precipitation – classification and mechanism.

Unit II: Tropical Climates and Weather Hazards: (15 hours)

General Circulation of the atmosphere and energy cycle - Carnot Cycle, Hadley Cell, Walker Circulation, ENSO phenomena; Tropical air mass; Convergence and divergence, The Asian Monsoon: Importance, characteristics, and prediction; Weather hazards – Heat and cold waves, thunderstorm, tornado and cyclone - Theories of genesis and formation, distribution, significance, forecasting and roles of climate stakeholders (Case Study on Indian Metereological Department (IMD) .

Unit III: Climate Change: (15 hours)

The climate system: Micro, Meso and Macro; Linkages of climate with other environmental systems, Scientific evidences of climate change; Reconstruction of past climates – paleoclimatology, Theories and models of climate change; Prognostication of future climates, The climate cycle; Climate trends in the Holocene period, Recent trends of global climates: Feedback mechanism, Implications and arguments; Climate modelling, climate models – Global Climate Models (GCM) and Regional Climate Models (RCM)-theories and methods; Exoplanet Climatology.

Unit IV: Applied Climatology: (15 hours)

Approaches and techniques of weather forecasting with reference to the tropics: short, medium and long range, weather satellites – functions and characteristics, benefits of weather forecasting in disaster prevention and preparedness; Climate and agriculture: Agro-climatology (Agro-climatic Zones, climate-related risks, policy and prevention with climate-smart agriculture), Climate and settlements: Urban micro climatology – Urban Heat Island and Architecture (Case Studies of UHI Mitigation in Architecture with reference to India), Climate and health: Bio-climatology (Climate Factors Affecting Human Comfort, Biometeorological Indices, Morbidity Patterns and Climate Variability,Vulnerability and Adaptation Strategies)

Recommended Readings:

1. Ackerman, S.A. and Knox, J.A. (2012): Meteorology: Understanding the Atmosphere, Jones & Bartlett Learning, London.
2. Atkinson, B. W. (Ed.) (1981): Dynamical Meteorology: An Introductory Selection, Methuen, London.
3. Barry, R.G. and Chorley, R.J. 1985: Atmosphere, Weather and Climate, Methuen London
4. Blair, T.A. and Fite, R.C. 1965: Weather Elements: A Text in Elementary Meteorology, Prentice Hall, New York
5. Byers, H. R. (1974): General Meteorology, McGraw-Hill Book Company, New York
6. Chandrasekar, A. (2010): Basics of Atmospheric Science, PHI Learning Pvt. Ltd., New Delhi
7. Critchfield, H.J. 1966: General Climatology, Prentice Hall, New York.
8. Das, P.K., 1988: The Monsoons, National Book Trust, India, New Delhi.
9. Houghton, J. (2002): Physics of Atmosphere, Cambridge University Press, Cambridge.
10. Henderson-Sellers, A. and Robinson, P.J. 1966: Contemporary Climatology, ELBS/ Longman.
11. Lutgens, F.K. and Tarbuck, E.J. 1982: The Atmosphere: An Introduction to Meteorology, Prentice Hall, New York.
12. Lydolph, P.E. 1985: The Climate of the Earth, Rowman and Allan Held, New Jersey.
13. Mather, J.R.,1974.: Climatology: Fundamentals and Applications, McGraw Hill,New York.
14. Mcllveen, R. (2010): Fundamentals of Weather and Climate, Oxford University Press, Oxford.
15. Musk, L.F. 1988: Weather Systems, Cambridge University Press, Cambridge.
16. Pettersson, S. 1958: Introduction to Meteorology, McGraw Hill, Tokyo.
17. Rayner, J.N. (2001): Dynamic Climatology - Basis in Mathematics and Physics, Blackwell Publishers Ltd., Oxford.
18. Robinson, H. 1982: Biogeography, ELBS/ McDonald and Evans, London.
19. Rohli, R.V. and Vega, A. J. (2012): Climatology, Jones & Bartlett Learning, London
20. Trewartha, G.T. 1968: An Introduction to Climatology, McGraw Hill, New York.
21. Thompson, R. D. (1998): Atmospheric Pressures and Systems, Routledge, London
22. Wallace, J.M. and Hobbs, P.V. (1977): Atmospheric Science: - An Introductory Survey, Academic Press, New York.

Websites:

1. India Meteorological Department: www.imd.gov.in
2. Intergovernmental Panel on Climate Change: www.ipcc.ch
3. World Bank Climate Change Knowledge Portal: sdwebx.worldbank.org/climateportal/index.cfm
4. World Meteorological Organization: public.wmo.int/en

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	2	2	1	2	2	1	2	3	3	3	3	3
CO 2	3	3	3	2	1	2	2	1	2	3	3	2	3	2
CO 3	3	2	3	3	1	3	2	1	2	3	3	3	3	3
CO 4	2	2	3	3	2	3	3	1	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO460	Philosophy of Geography	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	Undergraduate level knowledge of evolution of geographical thought.				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. **Summarize** the evolution of geography as a spatial science with a focus on positivism, behaviouralism, radicalism and humanistic geography.
CO2. **Explain** the critical perspectives of post-modern geography in relation with space, place and identity.
CO3. **Relate** contemporary trends of new geographies with globalization, economy and society.
CO4. **Discuss**the contemporary pedagogies and research frontiers in geography with the revival of studies in man-environmental relationship.

Course Content

Unit I: Development in Modern Geographical Thought (15 Hours)
Geography – an interdisciplinary approach, Geography and man-environment relationships – Determinism to Neo- Determinism – changing paradigms; Place of Geography in the classification of knowledge after Varenius and Kant; Evolution of Geography as a spatial science and Quantitative Revolution, Positivism in Geography: Explanation and search for scientific routes, Critiques of Positivism: Behavioural Geography and Radical Geographies, Existential phenomenology and Humanistic Geography

Unit II: Emergence of Critical Perspectives (15 Hours)
Crisis of Modernity, Impact of World Wars, and the shift towards critical perspectives, Post modernity and the production of space after Lefebvre, Harvey and Soja, Geography of Gender – chronological geographies of Gender; Feminist Geography: space, place and identity- concepts and evolution and Gendered Space in Geography, Queer Geography.

Unit III: Changing trends and Dimensions (15 Hours)
Geography of inequality, Colonial and Post-colonial interpretations in Geography, Geography in the era of globalization: Political-economic perspectives in spatial relations, New Geographies: Select ideas of Environment and Human Geography- Contesting environment and socializing Nature. New Social Geographies: Hybrid Geography, Critical Race Theory

Unit IV: Contemporary Pedagogies and Research Frontiers in Geography (15 Hours)
Revival of Classical ideas, Critical appreciation of Darwin's contribution, Revival of Man-environment relations: Revival of Ecological Studies, Urban Political Ecology, Research, Pedagogy, and Instrumental Geography – contemporary practices; Development of Geography in India

Recommended Readings:
1. Adhikari, S. (1992): Fundamentals of Geographical Thought, Chaitanya Publishing. House, Allahabad.

2. Beramendi, Pablo: The Political Geography of Inequality: Regions and Redistribution, Cambridge.
3. David Harvey: Explanation in Geography, 1986
4. David Harvey: Spaces of Capital. Towards a Critical Geography, Routledge, 2001
5. Dixit, RD: Geographical Thought: A Contextual History of Ideas, Rawat Publication, Delhi.
6. E. Soja: Postmodern Geographies: The Reassertion of Space in Critical Social Theory, 1989
7. Haggett. Geography– A Modern Synthesis.
8. Hartshorne, R. (1939): The Nature of Geography: Association of American Geographers, USA.
9. Harvey, D. (1969): Explanations in Geography, London.
10. Harvey, Milton E. and Brian, P. Holly (Ed.) (1981): Themes in Geographical Thought, Rawat Publication, Delhi.
11. Hossain, M. (1988): Evolution of Geographical Thought, Rawat Publications, Jaipur.
12. Johston, R. J. et al (Ed.) (1981) The Dictionary of Human Geography, Blackwell, England.
13. Peet, R. (Ed.) (1977): Radical Geography, Methuen, London.
14. Rachel Pain, Michael Burke, Duncan Fuller, Jamie Gough, Robert Macfarlane, Graham Mowl : Introducing Social Geographies, 2001
15. Tim Cresswell: Geographical Thought: A critical Introduction, Wiley-Blackwell, Year: 2013

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	0	1	2	1	2	3	1	1	2	1	2	1	2	1
CO 2	1	1	2	2	1	2	2	2	1	2	2	2	3	2
CO 3	2	2	2	1	3	2	0	1	2	1	2	1	1	1
CO 4	1	1	1	0	2	1	1	2	2	1	1	1	0	1
CO 5	0	1	2	2	3	2	2	1	1	2	3	2	2	2
CO 6	1	1	2	1	1	3	1	1	2	1	2	1	2	1

GEO461	**Geostatistics Lab**	L	T	P	C
Version 1.0	**Contact Hours – 90**	0	0	6	4
Pre-requisites/Exposure	Undergraduate level knowledge of Statistics and Probability				
Co-requisites	Basic knowledge of computer skills				

Course Outcomes

On completion of this course, the students will be able to:

CO1. Explain the structure of geographical data and its distribution characteristics.
CO2. Analyze location-oriented problems with spatial data models.
CO3. Apply statistical techniques for hypothesis testing using sample datasets.
CO4. Evaluate relationships between variables in spatial contexts.
CO5. Interpret results from spatial and geostatistical analysis tools.
CO6. Develop geographic data models to address applied research questions.

Course Content

Unit I: Geographers' data exploration (30 Hours)
Geostatistics and Geographical Data - Introduction to GDM (Geographer's Data Matrix); Measuring Geographical Data: forms, scales, classification and techniques; Data Exploration - Graphical examination, Missing Data, Outliers, Incorporating dummy variables and random numbers; Sampling and estimation; Measures of central tendency, dispersion and data distribution – descriptive vs. inferential statistics; Data consistency and validation (Likert Scale, latent variables and Cronbach's alpha test).

Unit II: Geographical Data Analysis (30 Hours)
Univariate data analysis (measures of central tendency, dispersion and distribution); Bivariate statistics (correlation and simple linear regression); time series analysis (moving average and trend line); spatial analysis (point – spatial mean and standard distance; line – directional statistics; areal pattern analysis)

Unit III: Inferential Statistics and Hypothesis Testing (30 Hours)
Hypothesis building- null and alternative, errors, Degree of freedom, Testing assumptions, Test of normality – Shapiro Wilk Test, Small sample and large sample test; Parametric Test – parametric data, Students' t-Test (paired and independent), Welch test; Non parametric test – Chi Square, ANOVA (one way), Kruskal–Wallis test, Multivariate Analysis, Heteroskadasticity in regression, Problem of Multi-collinearity

Laboratory Notebook and Viva voce

Recommended Readings:

1. Ashis Sarkar, Quantitative Analysis in Geography, Blackswan Publishers.
2. Banerjee, S, Carlin, B., and Gelfand, A. E. (2004) Hierarchical modeling and analysis for spatial data. Chapman & Hall
3. Chiles, J. P. and Delfiner, P. (1999) Geostatistics: Modeling Spatial Uncertainty. Wiley.
4. Clark, W.A.V. and Hosking, P.L. 1986: Geographical Methods for Geographers, John Wiley and Sons, New York.
5. Cressie, N. (1993). Statistics for Spatial Data (Revised Ed.). John Wiley & Sons, Inc.
6. Croxton, F.E., Cowden, D.J. & Klein, S 1969: Applied General Statistics, PrenticeHall of India Pvt. Ltd., New Delhi.
7. Dickinson, G.C. (1973): Statistical Mapping and Presentation of Statistics.
8. Goon, A.M., Gupta, M.K. &Dasgupta, B. 1992: Basic Statistics, Volume 1, TheWorld Press Pvt. Ltd., Kolkata.
9. Goon, A.M., Gupta, M.K. &Dasgupta, B. 1992: Fundamentals of Statistics, Volume 1, The World Press Pvt. Ltd., Kolkata.
10. Gregory, S. 1985: Statistical Methods and the Geographer, Longman, London.
11. Mahmood, A. 1998: Statistical Methods in Geographical Studies, Rajesh Publications, New Delhi.
12. Monkhouse, F.J. 1971: Maps and Diagrams, Methuen, London.
13. Norcliffe, G.B. 1977: Inferential Statistics for Geographers-An Introduction, Hutchinson and Co.,12. Pal, S.K. 1998: Statistics for Geo-Scientists- Techniques and Application, Concept Publishing Company, New Delhi.
14. Peter A. Rogerson, Statistical Methods for Geography, Sage Publications.
15. Peter J. Diggle, Paulo J. Ribeiro, Jr (2007) Model-based geostatistics, Springer.
16. Schabenberger, O. and Gotway, C. (2005) Statistical Methods for Spatial Data Analysis, Chapman & Hall/CRC.
17. Stein, M. L. (1999) Interpolation of Spatial Data: Some Theory for Kriging. Springer.
18. Wackernagel, Hans (1998) Multivariate Geostatistics (2nd ed.) Springer.
19. Kitanidis, P.K. (1997) Introduction to geostatistics: applications in hydrology.
20. Goovaerts,Pierre (1999) Geostatistics for Natural Resource Evaluation.
21. Olea, R. A. (1999) Geostatistics for Engineers and Earth Scientists.
22. Christakos, G (2000) Modern Spatiotemporal Geostatistics.
23. Webster, R. and Webster, M (2001) Geostatistics for Environmental Scientists.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	2	3	1	2	1	1	2	3	3	3	3	3
CO 2	3	3	3	3	2	2	2	2	3	3	3	3	3	3
CO 3	3	3	3	3	2	3	2	2	3	3	3	3	3	3
CO 4	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO462	Hydrology and Oceanography	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	Graduate level Hydrology knowledge				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. Explain the fundamental knowledge of hydrological cycles and measurements.
CO2. Apply techniques to address water crisis and management for urban and agrarian systems.
CO3. Discuss the principles and processes of oceanography, including physical and biological characteristics.
CO4. Evaluate factors of ocean water pollution and conservation strategies for marine ecosystems.
CO5. Analyze the impact of human activities on hydrological and oceanic systems.
CO6. Design sustainable management strategies for water and marine resources.

Course Content

Unit I: Basic Concepts of Hydrology (15 Hours)
Water in earth: forms, occurrences and properties; Global Hydrological Cycle and its significance; Measurement and analysis hydrological data: Precipitation, Infiltration, Evaporation, Transpiration, Run-off and Discharge; Stream flow analysis; Hydrographs and Rating Curves; Key Concept of ground water movement; Darcy's Law.

Unit II: Water Management Techniques in Hydrology (15 Hours)
Water management in tropical farmlands: Techniques and approaches of artificial rainmaking; Water management in tropical cities: Techniques and approaches of rainwater harvesting; Principles of integrated river basin management with special reference to micro-watershed planning; Issues related to damming of large rivers; River restoration and reconnection; Artificial recharge of groundwater; Concepts of environmental flows assessment.

Unit III: Concepts, Models and Configurations of Oceans (15 Hours)

Classification, characteristics and origin of the major structural and morphological features of the ocean floor with particular reference to plate tectonics, Bottom topography of Indian Ocean: characteristics and evolution, Waves and tides: Genetic classification and models of formation, Ocean circulation: classification and significance

Unit IV: Ocean Properties and Resources (15 Hours)

Water mass: origin and evolution; Physical and chemical properties of ocean water; Air-sea interactions, Sea-level change: types, causes and implications, Ocean as a resource: Anthropogenic utilization of the oceans, EEZ and CRZ: delimitation, significance and policy issues.

Recommended Readings:

1. Linsley, K., Kohler, M. and Paulhus, J.L. 1975: Applied Hydrology, Tata McGraw Hill, New York.
2. Meinzer, O.E. 1942: Hydrology, Dover Publication Inc. New York.
3. Rahgunath, H.M. 1997: Hydrology- Principles, analysis, Design, New Age International Pvt. Ltd, New Delhi
4. Sverdrup, H.U. 1942: The Oceans, their Physics, Chemistry and General Biology, Prentice-Hall, New York.
5. Todd, D.K. 1959: Ground Water Hydrology, John Wiley and Sons, New York
6. Walton, W.C. 1970: Ground Water Resource Evaluation, McGraw Hill, Tokyo
7. Davis Rechard J.A. 1986: "Oceanography-An Introduction to the Marine Environment". Wm. C. Brown lowa,.
8. Garrison, T.: "Oceanography - An Introduction to Marine Science" Books/Cole, Pacific Grove, USA, 2001.
9. Sharma, R. C. "The Oceans" Rajesh N. Delhi, 1985.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	2	2	1	2	1	1	2	3	2	2	3	3
CO 2	3	3	3	3	2	3	2	2	3	3	3	3	3	3
CO 3	3	2	2	3	1	2	2	1	2	3	3	3	3	3
CO 4	3	3	3	3	2	3	3	2	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO463	Political Geography and International Relations	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	Graduate level Political Geography knowledge				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. Describe the key concepts of political geography and the role of geopolitics in global power dynamics.
CO2. Analyze political settings and conflicts, particularly in India and its neighboring countries.
CO3. Evaluate the history and impact of global political organizations.
CO4. Explain the theories of international relations and the foreign policy of India.
CO5. Assess the role of India in international geopolitics and environmental diplomacy.
CO6. Apply political geography theories to understand global political structures and conflicts.

Course Content

Unit I: Political Geography and Geopolitics (15 Hours)
Definition, nature and scope of political geography, concept of geopolitics, Geo- strategic views of Mackinder and Spykeman and their relevance in contemporary world, Concepts of State, Nation, Nation-state, Nation- building, Capitals, Frontiers and Boundaries, Buffer zone and Buffer state, Land-locked nation, Enclaves and Exclaves

Unit II: Political Settings and International Disputes of India (15 Hours)

History and impact of partition of India; Federalism in India: political and administrative structure; India's international borders and water disputes with Pakistan, China and Bangladesh, National Security and Terrorism

Unit III: International Conflict and geopolitics (15 Hours)
History of cold war, Role of NATO and WTO, importance of ASEAN and SAARC, Geopolitical significance of Indian Ocean, international oil diplomacy and Afghanistan-Crisis

Unit IV: India and International Relations (15 Hours)
Theories of international politics, Determinants and characteristics of Indian foreign policy, India's Financial Policies, India's Nuclear Policy, India's relation with USA and Russia, Climate change and Environmental diplomacy, India’s role in the emerging Global Order

Recommended Readings:

1. Agnew, J. 2002: Making Political Geography, Arnold, London.
2. Chatterjee, A. 2010: International Relations Today- Concepts and Applications, Longman, New Delhi.
3. Cox, K.R., Low, M. and Robinson, J. (2008): The SAGE Handbook of Political Geography, SAGE Publications Ltd., London.
4. Cox, K.R., 2002: Political Geography: Territory, State and Society, Wiley-Blackwell, Chichester.

5. Dikshit, R.D. 2000: Political Geography: A Contemporary Perspective, Prentice-Hall, New Delhi.
6. Ghosh, P. 2013: International Relations, PHI Learning Ltd. New Delhi.
7. Glassner, M.I. 1993: Political Geography, John Wiley, New York.
8. Heywood, A. 2014: Global politics, Plagrave Macmillan, UK.
9. Painter, J. and Jeffrey, A. 2009: Political Geography, SAGE Publications Ltd., London.
10. Scott, D. (Eds) 2011: Handbook of India's International Relations, Routledge, London

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	2	2	1	2	2	1	3	3	2	2	3	2
CO 2	3	3	3	3	2	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	2	1	3	3	3	3	3	3
CO 4	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO464	Social and Cultural Geography	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	Undergraduate level knowledge of Social and Cultural Geography				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to:

CO1. Explain the concepts of social geography, including well-being, security, and justice.
CO2. Relate the determinants of social structures such as caste, ethnicity, and religion.
CO3. **Examine** the themes of cultural geography focusing on cultural landscapes.
CO4. Discuss cultural transformations through space, place, and social power.
CO5. Analyze the socio-cultural factors shaping rural and urban spaces.
CO6. Apply cultural and social theories to address issues of inequality and transformation.

Course Content

Unit I: Social Geography (15 Hours)
Social Geography: definition and elements; Social Structure, Social Processes, Social groups, Concept of Welfare and Social Well-being; Social Well-being in India, Social pathology, ;Social Security, Social Change, Social Justice and Social Inequality; Social Impact Assessment (SIA - Introduction, Legal and Regulatory Framework, Methods and Tools, Case Study, Integration of SIA into Decision-making Processes)

Unit II: Elements of Social Geography (15 Hours)
Genetics and Geography; Problem of classification, Caste: Depiction in the Ancient Texts of India - Varna and Jati - Patron Client Relationship, Caste in Colonial Period, Post Independent Caste Identity, Scheduled Caste and Backward Caste, Spatial Distribution of various castes in India; Concept of Tribe, spatial distribution in India, Society and cultural identity, Ethnicity– World and India; Concept of Religion - major religions of the World and India, minority population and issues of communalism, Dialects and Language – Geographical Pattern and Classification

Unit III: Cultural Geography (15 Hours)
Nature and scope of cultural geography; cultural landscape and cultural ecology; Cultural system and units of study – cultural trait, cultural area, cultural region, cultural realm and cultural hearth; Cultural diffusion and theory of adaptation; Cultural processes and pattern – ethnicity and enculturation, metropolitan culture and acculturation, assimilation, trans-culturation; Culture and Technology, cultural take off and role of digital media; Folk culture and Popular culture; cultural segregation and diversity; Cultural regeneration (case study on Community-led Cultural Regeneration Projects).

Unit IV: Social – Cultural Relations (15 hours)

Space, place and culture in geography; Threefold Division of Societies (R. Steiner), Theories of Social Formation, Transformation and cultural change: Functional Theory (T. Sarsons); Conflict Space and Power; Socio-cultural disintegration and spatial segmentation in India - examples from rural and urban areas.

Recommended Readings:

1. Admed, A (2004): Social Geography, Rawat Publication, New Delhi
2. Chapman, K. (1979): People, Pattern and Process – An Introduction to Human
3. Guha, R. C: Social Geography.
4. Jones, E. and Eyles, J. (1977): An Introduction to Social Geography, Oxford University Press, Oxford.
5. Rubenstain, J. M. and Becon, J. M. (1990): Cultural Geography, John Wiley and Sons Inc., New York.
6. Spencer, J. E. and Thomas, W. L. (1969): Cultural Geography, John Wiley and Sons Inc., New York.
7. Valentine. G. 2001, Social Geographies. Prentice Hall, Englewood Cl

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	2	2	2	1	2	2	1	2	3	2	2	3	2
CO 2	3	3	3	2	1	2	2	1	2	3	3	3	3	3
CO 3	3	3	3	2	1	3	2	1	2	3	3	3	3	3
CO 4	3	3	3	3	2	3	3	2	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO465	Advanced Geoinformatics	L	T	P	C
Version 1.0	Contact Hours – 90	0	0	3	2
Pre-requisites/Exposure	Fundamentals of Geoinformatics Lab, Geospatial Analysis and its Applications Lab				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to:

CO1. Demonstrate the application of advanced geospatial tools and software in analyzing geographic data.
CO2. Apply remote sensing and GIS techniques to solve spatial problems.
CO3. Create geospatial models to simulate geographic phenomena.
CO4. Interpret satellite images and maps to extract meaningful data.
CO5. Analyze spatial datasets for mapping and geographic visualization.
CO6. Present results of geospatial analysis in effective maps, reports, and visual formats.

Course Content

Unit I: Advanced Image Classification Techniques (10 Hours)

Generic image classification & advanced classification methods - object based image classification and machine learning based classification (SVM, Random Forest, Decision Tree); accuracy assessment and change detection of multi-temporal data

Unit II: Advanced Vector Operations (10 Hours)

Overview of tools for spatial analysis – Vector-based overlay operations: Point-in polygon, line-in-polygon, polygon-in-polygon; Single layer operations: Feature identification, extraction, classification manipulation. Multilayer operation: Union, intersection, symmetrical difference, update, merge, append and dissolve; Spatial analysis – Raster Based: Map algebra, grid-based operations, local, focal, zonal, and global functions

Unit III: Advanced Spatial Analysis Techniques (10 Hours)

Measuring Geographic Distributions: Mean centre, Median centre, and Standard Distance and SDE; Measuring pattern - Cluster and Outlier analysis; Hotspot analysis; Spatial Autocorrelation and Spatial Regression

Unit IV: Geospatial Modelling (15 Hours)

Site-Suitability Model; Multi-criteria decision analysis; weighted overlay; Evaluation of network complexity using Alpha, Beta, Gamma Indices; Types of network analysis: Least Cost Path Analysis; Location-Allocation Analysis.

Laboratory Notebook and Viva voce

Recommended Readings:

1. Chang, K-T., 2019: Introduction to Geographic Information Systems, McGraw Hill.
2. de Smith, M. J., Goodchild, M. F., Longley, P. A., 2018: Geospatial Analysis: A Comprehensive Guide to Principles, Techniques and Software Tools, Matador.
3. Haining, R., 2010: Spatial Data Analysis – Theory and Practice, Cambridge University Press.
4. Bailey, T. C., and Gatrell, A. C., 1995. Interactive Spatial Data Analysis, Routledge.
5. Burrough, P. A., McDonnell, R. A. and Lloyd, C. D., 2015: Principles of Geographical Information Systems, Oxford University Press.
6. Pick, J. B., 2008: Geo-business GIS in the Digital Organization, Wiley.
7. Singh, R. B., and Murai, S., 1998: Space-informatics for Sustainable Development, Oxford and IBH Pub.
8. Devillers, R. and Jeansoulin, R. (2006). Fundamentals of Spatial Data Quality, ISTE Ltd., USA.
9. Yue-hong Chou (1997). Exploring Spatial Analysis in Geographical Information System, Onward Press, Thomson Learning.
10. Berners-Lee, T. (1996). The World Wide Web: past, present, and future. Cambridge, MA: Massachusetts Institute of Technology, Laboratory for Computer Science. http://www.w3.org/People/Berners-Lee/1996/ppf.html.
11. Jones, C. B., and R.S. Purves (2008). Web-based GIS. In The Handbook of Geographical Information Science, eds. J. P. Wilson and A. S. Fotheringham, 559-580. Oxford: Wiley Blackwell.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	3	3	2	3	2	1	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

SEMESTER III

GEO500	**Geography of Environment, Hazards & Disaster**	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	Knowledge of UG level physical geography and basic environmental science				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. Describe the evolution of environmental perceptions and pollution impacts.
CO2. Understand land-use dynamics and landscape patterns.
CO3. Evaluate sustainable development issues in environmental contexts.
CO4. Explain the causes and management strategies for environmental hazards.
CO5. Analyze the socio-environmental dimensions of disaster management.
CO6. Apply techniques for mapping, monitoring, and managing environmental changes.

Course Content

Unit I: Environmental Pollution (15 Hour)

Geographers' approach to environmental studies; Environmental perception: significance; Physical Components of Environment: Lithosphere, Hydrosphere, Atmosphere, Biosphere and their relationship; Pollution: Air, Water, Soil, Noise pollutions, their sources, impacts, and management; green technology

Unit II: Concept of Hazards and Disasters (15 Hour)

Concepts of vulnerability, hazards, disaster, and risk; natural, quasi-natural, and man-made hazards and disasters; Social response; Natural hazards: Forest hazard, Desertification, Jhum cultivation; Social hazards: Poverty, Disease, Ward, and Crime - factors, impact, and redressal; Hazard and disaster reduction and management

Unit III: Environmental Issues (15 Hour)

Global resource crisis and population equilibrium, History of Earth Summits and significance of Sustainable Development, Relevance of Montreal and Kyoto Protocols, Biodiversity conservation and Genetically Modified Organisms, Big dams and their viable alternatives; International and Inter-State Water Dispute in the Indian subcontinent, Conservation of wetland and wasteland management

Unit IV: Impact of land use land cover dynamics on the environment (15 Hour)

Fundamental concepts of land as the basis of environment and society; Concept of land use and land cover; factors of land-use land cover change; Impact on the environment; Land degradation types, processes, and causes of land degradation, mapping, and monitoring of land degradation; Land Capability Classification (USDA); Land-use dynamics and landscape pattern - patches, corridors, and mosaics; measuring metrics (Shannon's Diversity Index and Simpson Diversity Index); Land Use Planning for Environmental Management

Recommended Readings:

1. Anderson J.M. (1981): Ecology for Environmental Science: Biosphere, Ecosystems and Man, Arnold, London.
2. Nobel and Wright (1996): Environmental Science, Prentice Hall, New York.
3. Odum, E.P. (1971): Fundamental of Ecology, W.B. Sanders, Philadelphia.
4. Saxena, H.M. (1994): PrayavaranevnParisthitikiBhugool (Geography of Environment and Ecology) Rajasthan Hindi Granth Academy, Jaipur.
5. Singh, Savinder (1991): Environmental Geography, Prayag Pustak Bhawan, Allahabad.
6. Strahler, A.N. and Strahler, A.H. (1973): Environmental Geosciences: Interaction between natural systems and Man, John Wiley and Sons, New York.
7. Strahler, A.H. and Strahler A.N. (1977): Geography and Mans Environment, John Wiley, New York.
8. William, M.M. and John, G. (1996): Environmental Geography - Science, Landuse and Earth System, John Wiley and Sons, New York.
9. Alexander, D. (1993): Natural Disasters, Research Press, New Delhi, 619 P.
10. Blaikie, P. Cannon, Davis and Wisenes (1994): At Risk, Natural Hazards, People's Vulnerability and Disasters, Pouthledge, London, 320 P. 15.
11. Bryant, E. A. (1991): Natural Hazards: Cambridge University Press, Cambridge, Pg 294.
12. Burotn, I. Kates, R. W. and White, G. F. (1974): The Environment as a Hazard, Oxford University Press.
13. 17. Coch, N. C. (1994): Geo-Hazards, Prentice Hall, N. Y., Pg.305.
14. Environment and Development: R. Bhattacharyya, (Edited).
15. Environmental Geology: B. W. Murck and et al, John Willey.
16. Gilbert, F. White, ed. (1974): Natural hazards – Local, Natural and Global, Oxford University Press, N.Y.
17. Morrisawa, M., (1996): Geomorphology and Natural Hazards,Elscvia, Amsterdam, pg 411
18. Natural Hazard: Edited by White.
19. Smith, K. (1996): Environmental Hazards: Assessing Risk and Reducing Disaster, Routledge, Pg.398.
20. Turner, M.G., Gardner, R.H. and O'Neill, R.V. (2001): Landscape Ecology in Theory and Practice:
21. Pattern and Process, Springer Science & Business Media, New York
22. Jana, N.C. and De, N.K. (1997): The Land - Multifaceted Appraisal and Management, Sribhumi Publishing Company, Kolkata

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	3	2	1	2	2	1	2	3	3	3	3	3
CO 2	3	2	3	3	2	3	2	2	2	3	3	3	3	3
CO 3	3	3	3	3	2	3	3	1	3	3	3	3	3	3
CO 4	2	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO501	**Geospatial Analysis and its Applications Lab**	L	T	P	C
Version 1.0	**Contact Hours – 90**	0	0	6	4
Pre-requisites/Exposure	Fundamental concepts of geoinformatics lab				
Co-requisites					

Course Outcomes

On completion of this course, the students will be able to:

CO1. Identify and interpret geospatial data from topographical maps, aerial photos, and satellite images.
CO2. Analyze geomorphic and fluvial features, including channel patterns and landform evolution.
CO3. Develop techniques for mapping settlement patterns and cultural features.
CO4. Apply spatial analysis to measure geographic distributions and interactions.
CO5. Evaluate the spatial organization of physical and cultural features.
CO6. Synthesize geospatial data to produce effective geographic maps and visualizations.

Course Content

Unit I: Geospatial Data Sources (30 Hours)

Geospatial data sources – Comparative utility of topographical maps, aerial photos, and satellite images as sources of geographical data;

Unit II: Identification and Interpretation of Physical Features: (30 Hours)

Identification and mapping of macro and micro geomorphic features, morphometric analysis Demarcation and mapping of fluvial features - Long and cross profiles, channel and drainage pattern, channel meandering, river terraces and alluvial fan, Quantitative analysis, and measurement of fluvial features - hypsometric curves, Stream ordering, Bifurcation Ratio, channel shifting, and bank erosion

Unit III: Identification and Interpretation of Cultural Features: (30 Hours)

Preparation of maps showing types and patterns of settlements depending on their sites and situation; Demarcation and mapping of the hierarchy of settlements and utility centers, measuring spatial interactions; Interpretation and interactions among physical and cultural features

Laboratory Notebook and Viva Voce

Recommended Readings:

1. Dury, G.H. 1972: Map Interpretation, Pitman Publishing, London
2. Ishtiaque, M. 1989: Practical Geography, Heritage Publishers, New Delhi.
3. Monkhouse, F.J. 1971: Maps and Diagrams, Methuen, London
4. Robinson, A.H., Morrison, J.L., Muehrcke, P.C., Kimerling, A.J. and Guptill, S.C. 1995: Elements
5. of Cartography, John Wiley and Sons, New York.
6. Bhatta B., 2011: Remote Sensing and GIS, Oxford Publisher
7. Campbell J. B., 2007: Introduction to Remote Sensing, Guildford Press.
8. Jensen J. R., 2004: Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	3	3	2	3	2	2	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO502	Geocomputation and Geovisualisation Lab	L	T	P	C
		0	0	3	2
Pre-requisites/Exposure	Undergraduate knowledge of Geography				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. Classify geographic data using machine learning-based algorithms.
CO2. Develop models using remote sensing and GIS-based applications in R and Python.
CO3. Design WebGIS applications based on open-source software.
CO4. Prepare charts and reports from analyzed data.
CO5. Interpret data visualizations for geographic insights.
CO6. Apply advanced techniques in geocomputation for real-world geographic issues.

Course Content

Unit I: Basics of Geocomputation and Programming (15 Hours)

Introduction to Geocomputation and model- a. Definition of Geocomputation, Components of Geocomputation. Philosophical issues of Geocomputation, b. GIS and Geocomputation. Introduction to R and R Studio- a. Origin of R and R studio, b. Different Libraries of R, Load data into R, Understanding different types of variables, data frame, vectors, array and matrix, Basic Remote Sensing and GIS function in R- a. Read raster data in R, projection assignment, reprojection, resampling, preparation of FCC in R,subseting, band arithmetic, reclassification. b. Read vector data in R, explore .shp file attributes in R, basic visualisation with .shp file, splitting and merging of .shp file, basic analysis of .shp file; Introduction to Python and Basic python programming- a. Introduction of computer programing and Python IDEs b. Variables, data type & structure, operators & expression, c. Control flow, functions, input-output, error & exception handling.

Unit II: Automation and Visualisation (15 Hours)

Model building and GIS automation- a. Model building and its objectives, parameters for model building, exploring tool box for model building in software environment, environment associated with tools b. GUI based tool operation for model building, advanced geoprocessing and model building, d. 3D thematic map, DEM and LIDAR based geovisualisation, map animation and emerging issues of geovisualisation.

Unit III: GIS based Modelling (15 hours)

Fuzzy logic based optimization in GIS, Introduction to fuzzy, classic sets and logic, fuzzy set theory, fuzzy logic, possibility and probability, application of fuzzy in GIS, Neural networks-a. Introduction of computational neural network, how do computational neural networks work, characteristics of the processing elements, network topologies, learning in a computational neural network, advantages, application domains and examples, Concept of Cellular automata - a. The origins of cellular automata, concept of neighbourhoods, transitions, and conditions, b. Basic cellular automata: growth from single seeds, many seeds, complete development and self organisation, c. Application of cellular automata.

Recommended Readings:

1. Fisher M.M., 2006: Spatial Analysis and GeoComputation, Springer
2. Longley P.A et al., 1998: Geocomputation: A Primer, Wiley
3. Xing H., 2009: Advances in Geocomputing, Springer
4. Openshaw S. &Abrahart R. J., 2000: GeoComputation, CRC Press
5. Fisher M.M. & Leung Y. (Ed.), 2001, GeoComputational Modelling: Techniques and Applications,
Springer
6. Murganate B et al., 2009: Geocomputation and Urban Planning, Springer
7. Dixon B. &Uddameri V., 2015: GIS and Geocomputation for Water Resource Science and Engineering, Wiley.
8. Thill J. C &Dragicevic S. (Ed.), 2018: GeoComputational Analysis and Modeling of Regional Systems, Springer.
9. Sanders L.(Ed.), 2007: Models in spatial analysis, Wiley
10. Brusdon C. & Comber L., 2015: An Introduction to R for Spatial Analysis and Mapping, SAGE
Publications

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	3	3	2	3	2	2	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO503	Environmental Geography I	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	Basic concepts of environment, climate and biogeography				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. Understand advanced theories and concepts in environmental geography.
CO2. Analyze the impacts of human activities on environmental systems.
CO3. Evaluate strategies for sustainable resource management and environmental conservation.
CO4. Assess global and regional environmental challenges, such as climate change and biodiversity loss.
CO5. Apply spatial tools to study environmental degradation and propose solutions.
CO6. Develop comprehensive reports on environmental issues, integrating scientific and policy perspectives.

Course Content

Unit I: Concept (15 Hours)
Scope, Content and Recent Dimensions of Environmental studies in Geography, Symbiosis between Man and Environment; Effects of Environment on man: Bio-physical, Perceptional, Behavioral and that related to Resource Availability; Effects of Man on Environment with changes in Mode of Production; Physical, Ecological and Human Ecological Issues, Holistic and Reductionist Approaches to Environment

Unit II: Atmospheric Changes and the Biosphere (15 Hours)
Climatic Factors shaping the Geographical, Zoning and its Periodicity; Changing Climate of the World; Climatic Hazards and Management, Health Risks; Biomes and their relationships to Climate and Hydrological Cycle

Unit III: Energy and the Environment (15 Hours)
Ecosystem Approach in Environmental Studies; Bio-geo-chemical Cycles and their significance; Flow, Fixation and Balance of Energy in the Biosphere; Energy and Biomass Pyramid; Exchanges among Ecosystems and Changes of Ecosystems, Environmental Modelling

Unit IV: Environmental Degradation (15 Hours)
Concepts and types of environmental degradation; Causes of environmental degradation; Pollution: measurement techniques, impacts and mitigation: Air pollution, Noise Pollution, Water pollution: Waste water treatment, Arsenic Pollution: Spatial distribution; Solid waste; Nuclear fallout; E-waste management

Recommended Readings:

1. Biswas, T.D. and Mukherjee, S. K. 1987: Text book of Soil Science, Tata McGraw Hill, New Delhi.
2. Buckman, H.R. and Brady, N.C. 1974: Nature and Properties of Soil, McMillan, New York.
3. Bunting, A. 1965: Geography of Soil, Hutchinson, London.
4. Chapman, J.L. and Reiss, M.J. 1992: Ecology Principles and Applications, Cambridge University Press, Cambridge.
5. Daji, J.A., Kadam, J.R. and Patil, N.D. 1996: A Textbook of Soil Science, Media Promoters and Publishers Pvt Ltd, Mumbai.
6. Joffe, J. S. 1965: ABC of Soil.
7. Kormondy, E. J. 1991: Concepts of Ecology.
8. Nebel, J.B. 1981: Environmental Science, Prentice Hall, New York.
9. Odum, F.P. 1971: Fundamentals of Ecology, W.B. Sanders, Philadelphia.
10. Robinson, H. 1982: Biogeography.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	3	2	2	3	2	1	3	3	3	3	3	3
CO 2	3	3	3	3	2	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO508	Environmental Geography I Lab	L	T	P	C
		0	0	3	2
Pre-requisites/Exposure	Advanced Environmental Geography theory knowledge				
Co-requisites	Statistics and basic chemistry knowledge				

Course Outcomes

On completion of this course, the students will be able to

CO1. **Apply** the knowledge of sampling and instrumentation for collecting environmental data for air, water and noise pollution parameters.
CO2. **Experiment** to detect pollutant through laboratory testing of air and water samples.
CO3. **Analyze** primary and secondary data through statistical analysis and mapping.

Course Content

Unit I: Environmental Survey and Field Techniques (15 Hours)
Identification and study of an Environmental Problem in field, Sampling and survey procedures for different environmental parameters, Sampling and survey procedures for identification of impact parameters, Laboratory visit at the major research institutes: Central Ground Water Board (CGWB), Central Pollution Control Board (CPCB), National Environmental Engineering Research Institute Zonal Laboratory (CSIR – NEERI)

Unit II: Laboratory Techniques to Detect Environmental Pollution (15 Hours)
Acidity and Alkalinity of Water, Nitrate and Phosphate content in Water, BOD and Total hardness in Water, Dust fall and Measurements of Air-pollutants, Noise pollution

Unit III: Mapping Techniques (15 Hours)
Regression Analysis, Correlation and (bi – variate) Time Series Analysis of Environmental data, Concentration by Lorenz Curve, Probability distributions- binomial, poisson and normal, Sampling theory- hypothesis testing and interval estimation for large samples. Chi-square test, t-test and F-test of significance, Cartographic representation of Primary/Secondary data and generation of Environmental Maps in GIS platform, Preparation of the Environmental Management Plan (EMP)

Unit IV: Laboratory Note Book and Viva-voce

Recommended Readings:
1. William J. Sutherland (2006): Ecological Census Techniques Edited by Cambridge 2nd edition
2. Lagacherie Philippe, McBratney Alex and Voltz Marc(2006) : Digital Soil Mapping :An Introductory Perspective, Elsevier

3. Scull, P.; J. Franklin, O.A. Chadwick & D. McArthur (June 2003). Predictive soil mapping - a review.
4. Progress in Physical Geography, Sage Publications.
5. Monkhouse, F.J. 1971: Maps and Diagrams, Methuen, London
6. Singh, R.L. and Singh, R.P.B. 1992: Elements of practical Geography.
7. 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.
8. Basu, R. and Bhaduri, S. ed, 2007: Contemporary Issues and Techniques in Geography, Progressive Publishers, Kolkata.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	1	1	2	1	1	2	3	1	2	1	2	1	2	1
CO 2	1	1	2	2	2	3	2	2	2	2	2	2	3	2
CO 3	1	0	2	1	3	1	2	1	2	1	2	1	1	1
CO 4	0	1	1	1	2	3	1	2	3	1	2	1	0	1
CO 5	1	1	2	2	2	1	2	1	2	2	0	2	2	0
CO 6	1	1	2	1	2	3	3	1	2	1	2	1	2	1

GEO504	Applied Geomorphology and Hazard I	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	UG level knowledge of Geomorphology and Hazard				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. Demonstrate techniques for analyzing environmental data using geospatial tools.
CO2. Apply advanced field survey methods for studying environmental features.
CO3. Interpret satellite imagery and maps to assess environmental changes.
CO4. Analyse environmental datasets to evaluate pollution, biodiversity, and climate trends.
CO5. Develop comprehensive maps and reports for environmental planning.
CO6. Present findings of environmental analysis using advanced visualization tools.

Course Content

Unit I: Introduction to Applied Geomorphology (15 Hours)
Geomorphology vs. Applied geomorphology, Environmental impacts on Geomorphological processes, Geomorphological Resources: Geomorphological raw materials, Contribution of geomorphology in the search for other natural resources.

Unit II: Concept of Tectonic, Hydrology and Climatic Geomorphology (15 Hours)
Geology, tectonic and geomorphology: Lithology and landforms; structure and landforms, Hydrology and Geomorphology: Hydrology vs. landform development; Environmental conditions governing precipitation, evaporation, runoff and Hydrological Cycle, Climatic Geomorphology: Concept, Weathering and Landforms, Diagnostic landforms (Arid, tropical and quaternary), Geomorphological processes and climatic control, climate change and geomorphology, morphogenetic regions

Unit III: Introduction to Anthropogenic Geomorphology (15 Hours)
Anthropogenic Geomorphology: Meaning and concept, Man's impacts on Geomorphological and Geo hydrological processes, Geomorphological consequences of hunting, animal farming, agriculture, Impacts of resource exploitation and engineering works on Geomorphological landscape.

Unit IV: Endogenetic hazards-Earthquake and Volcanism (15 Hours)
Causes, impact and Assessment of Earthquake; Seismic risk and seismic susceptibility, Morpho – Neotectonics, Earthquake-triggered mass movements; Causes, impact and Assessment of Earthquake, Causes, types, impact and Assessment of Volcanic harzards, Prediction and Management of Volcanic harzards.

Recommended Readings:

1. Faniran, A. and Jeje, L. K. (1983): Humid Tropical Geomorphology, Longman, London.
2. Thomas, M. F. (1994): Geomorphology in the Tropics: A study of weathering and denudation in low latitudes. John Wiley and Sons, Chichester.
3. Kale, V. S. and Gupta, A. (2001): Introduction to Geomorphology, Orient Longman, Calcutta.
4. Goudie, A. (1985): Duricrusts in tropical and sub-tropical landscapes. Alien Unwin.
5. Savindra Singh (2002): Geomorphology, PrayagPustakBhawan, Allahabad.
6. Bloom, A. L. (2002). Geomorphology: A systematic analysis of late Cenozoic landforms. Prentice-Hall of India, New Delhi.
7. Panizza, M. (2002): Environmental Geomorphology, Elsevier.
8. Gutierrez Elorza, M., (2005): Climatic Geomorphology, Elsevier.
9. Thornbury, W. D. (1986): Principles of Geomorphology. Willey Eastern Limited.
10. Dayal, P.: A Textbook of Geomorphology. Shukla Book Depot, Patna.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	3	3	2	3	2	1	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO509	Applied Geomorphology and Hazard I Lab	L	T	P	C
		0	0	3	2
Pre-requisites/Exposure	UG level knowledge of Geomorphology and Hazard				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. Demonstrate techniques for analyzing environmental data using geospatial tools.
CO2. Apply advanced field survey methods for studying environmental features.
CO3. Interpret satellite imagery and maps to assess environmental changes.
CO4. Analyse environmental datasets to evaluate pollution, biodiversity, and climate trends.
CO5. Develop comprehensive maps and reports for environmental planning.
CO6. Present findings of environmental analysis using advanced visualization tools.

Course Content

Unit I: Lab based- Weather analysis (15 Hours)
Rainfall depth and persistence analysis, Rainfall coefficient analysis, Stage-discharge rating curve, Rainfall threshold estimation.

Unit II: Lab based- Topography analysis (15 Hours)
Determination of topographic erosivity, Annual flood frequency analysis; Flood Hazard Zonation, Landslide hazard zonation, Earthquake hazard zonation.

Unit III: Field based (15 Hours)
Micro-slope mapping and identification by Abney level, Traversing and contouring of a slope by Prismatic and Dumpy level, Slope analysis by Theodolite.

Unit IV: Laboratory Note Book and presentation

Recommended Readings:
1. Lagacherie Philippe, McBratney Alex and Voltz Marc (2006): Digital Soil Mapping: An Introductory Perspective, Elsevier
2. Scull, P.; J. Franklin, O.A. Chadwick & D. McArthur (June 2003). Predictive soil mapping - a review. Progress in Physical Geography, Sage Publications.
3. 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
4. Monkhouse, F.J. 1971: Maps and Diagrams, Methuen, London
5. Singh, R.L. and Singh, R.P.B. 1992: Elements of practical Geography.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	3	3	2	3	2	1	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO505	Urban and Regional Planning I	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	Undergraduate level knowledge of urban geography, regional planning and development and settlement geography				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. Apply geomorphological techniques to analyze landscapes and hazard-prone areas.
CO2. Demonstrate the use of tools and software for hazard mapping and risk assessment.
CO3. Evaluate the geomorphic processes contributing to hazards like landslides, floods, and earthquakes.
CO4. Analyze spatial data to identify vulnerable areas and propose mitigation strategies.
CO5. Create thematic maps for hazard management and environmental planning.
CO6. Present findings of geomorphic and hazard analyses in reports and maps.

Course Content

Unit I: Basics of Regional Planning (15 Hours)
Regions and regional planning: concepts, indicators, strategies, issues and significances, Evolution: concept of growth and development, heritage of regional planning and development, need of planning, Rethinking on development: Concepts of Seers, Club of Rome, Neo-Marxist, Theories of spatial organisation and integration: North, Perloff, Friedmann, Raza and Chattopadhay and planning regions in India

Unit II: Urbanization and Urban Planning (20 Hours)
Urbanization and history of urban space: determinants of urbanization, processes and forms, Early Urban hearths – emergence of town planning and postindustrial urbanization, post - modern urban spaces and types, urban morphology – urban landscape and landuse, Concept of urban planning; elements of urban structure (networks, buildings, open spaces etc.) and aspects of urban planning, Rationality and Sustainability in planning, Urban planning and Contribution of Planners: Robert Owen, James Silk, Don Arturo, Soria y Mata, Patrick Geddes, Patrick Abercrombie, Tony Garnier, Le Corbusier, Clarence Perry , Frank Lloyd Wright

Unit III: City and Metropolitan Planning (25 Hours)
Concept and growth of cities – cities as engines of growth, cities as ecosystems, resources in cities, City and its linkages - City, fringe and the periphery, Concept of metropolitan: evolution, composition, historical background and functional hierarchy; Planning of early metropolitan regions – case studies from Western and Eastern countries, Introduction to Global metropolitan regional plans – twin towns, policy of London – Industrial Location Policy of South Korea – Finger Plan of Copenhagen, Metropolitan regions in India – processes and forces, influencing the

metropolitan development - Five Year Plans and metropolitan planning in India – Metropolitan regional development agencies in India, Case studies of Metropolitan regional development plans - Delhi, Mumbai and Calcutta metropolitan regional development plans – important features and policy initiatives undertaken.

Recommended Readings:

1. Carter, H (1972): The Study of Urban Geography, Edward Arnold.
2. A. Latham, D. McCormack, K. McNamara, D. McNeill (2009): Key Concepts in Geography, Sage.
3. Harvey, D.(1973): Social Justice and the City, Arnold
4. Abu-Lughod, J. and Hay, R. Jr. (1977): Third World Urbanisation, Maarouta Press.
5. Gugler. J. (ed.)(1988): The Urbanisation of the Third World, O.U.P
6. Sassen, S. (1991): The Global City, Princeton University Press.
7. Clarke, D. (1982): Urban Geography: An Introductory Guide, Groom Helm.
8. Marcuse, P. and Kempen, R.V. (eds.),(2000): Globalizing Cities: A New Spatial Order, Blackwell.
9. Short, J. R. (1996): The Urban Order, Basil Bleckwell.
10. Smith, N. (1996): The New Urban Frontier, Routledge
11. King A. D. (1990): Global Cities, Routledge.
12. Simmonds, R. and Hack, G. (2000): Global City Regions, Spon Press.
13. Markusen, A.R., et al. (1991): Second Tier Cities- Rapid Growth beyond the Metropolis, University of Minnesota Press.
14. Allen J. Scott (ed.), (2001): Global City Regions, Trends, Theory & Policy, Oxford University Press.
15. David Harvey (1985): The Urbanization of Capital, John Hopkins University Press.
16. Edward Soja (2000): Postmetropolis, Critical Studies of cities and Regions, Blackwell Publisher Ltd.
17. G. P. Chapman, A.K. Dutt and R.W. Bradnock (ed.) (1999): Urban growth & Development in Asia,Vol.2: Living in the Cities, Ashgate Publishing Ltd.
18. Pieterse E, (2008): City Futures, Confronting the Crisis of Urban Development, Zed Books Ltd, London and New York.
19. G. K. Bandopadhyaya , "Text Book of Town Planning".
20. Peter Hall, "Urban and Regional Planning".
21. F. S. Hudson," Geography of Settlements", and Evans Ltd. Estover, Plymouth PL 6 7 PZ UK
22. Abdul Razak, M. (2004) Mobility patterns and strategies used for spatial access to work of the squatter households in the peri-urban Delhi, India. Paper presented at the International
23. Abu-Lughod, J. L. (1999) New York, Chicago, LosAngeles: America's Global Cities. Minneapolis, MN: University of Minnesota Press.
24. AIILSG (All India Institute of Local Self Government)(2004) Transforming Mumbai into aworld class city. AIILSG, Mumbai.
25. Banerjee-Guha, S. (1997) Spatial Dynamics of International Capital. Hyderabad: Orient Longman.
26. Banerjee-Guha, S. (2002a) Metropolitan dominance and regional disparity in India: observations fromrelevant planning measures of Japan, Visiting Research Fellow Series No. 358, Instituteof DevelopingEconomics, Japan External Trade Organization.
27. Banerjee-Guha, S. (2002b) Shifting cities: urban restructuring in Mumbai, Economic and PoliticalWeekly, pp. 121–128.

28. Banerjee-Guha, S. (2008) Space relations of global capital and significance of new economic enclaves: SEZs in India, Economic and Political Weekly, 43(47), pp. 51–61.
29. Beaverstock, J. V., Smith, R. G. and Taylor, P. J.(1999) A roster of world cities, Cities, 16, pp. 445–458.
30. Cadene, P. and Marius-Gnanou, K. (2004) Peri urban dynamics: around the Indian metropolises:somefindings from the Chennai experience, Paper presented at the International workshop on 'Peri-urbanDynamics',National University of Singapore, December.
31. CIDCO (City and Industrial Development Corporation of Maharashtra) (1973) A report on thedevelopment of New Bombay, Bombay
32. D'Monte, D. (2002) Ripping the Fabric: The Decline of Mumbai and Its Mills. New Delhi: OxfordUniversity Press.
33. Dea´k, C. and Schiffer, S. (2007) Sa˜o Paulo: the metropolis of an elite society, in: K. Segbers (Ed.) TheMaking of Global City Regions: Johannesburg, Mumbai/Bombay, Sa˜o Paulo, and Shanghai, pp. 85–112.Baltimore, MD:Johns Hopkins University Press.
34. Dupont, V. (2004) Peri-urban dynamics: population, habitat and environment on the peripheries of largeIndian metropolises. Introductory paper at the International Workshop on 'Periurban Dynamics', NationalUniversity of Singapore,December.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	3	3	2	3	2	1	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO510	Urban and Regional Planning I Lab	L	T	P	C
		0	0	3	2
Pre-requisites/Exposure	Undergraduate level knowledge of field studies, data collection techniques and analysis				
Co-requisites	Familiar with the GIS, RS and statistical software				

Course Outcomes

On completion of this course, the students will be able to:

CO1. **Demonstrate** the use of spatial analysis tools in urban and regional planning.
CO2. **Apply** GIS techniques to analyze urban growth, land use, and infrastructure.
CO3. **Evaluate** regional disparities using socio-economic and spatial data.
CO4. **Create** maps for planning urban housing, transportation, and resource allocation.
CO5. **Analyze** the impact of urban policies through spatial models and simulations.
CO6. **Present** planning outcomes effectively through visual and written reports.

Course Content

Unit I: Data query – methods and techniques (15 Hours)
Geospatial and non – spatial data collection – characteristics and techniques; Instrument development and validation for urban-centric field visits and perception mappings; Techniques of preparing base maps using RS and GIS environments; including the concepts of scales, components and detailing for various levels of plans like regional plan, city plan, zoning plan, and local area plan

Unit II: Exploratory Analysis (15 Hours)
Urban landuse-land cover classification, change detection, and accuracy assessment; Simulating Intraurban Land Use Dynamics; cellular automaton and markov model; classification and identification of metropolitan regions

Unit III: Case studies in urban planning (15 Hours)
Mini project and case studies on housing-building typology and layouts, population composition and densities; streets, junctions, and connectivity; open spaces and its hierarchy; heritage buildings; health infrastructure and market economy.

Unit IV: Laboratory Notebook and Viva voce

Recommended Readings:
1. Robinson, A. H. and Others (1995): Elements of Cartography, VI Edition, John Wiley & Sons, New York.

2. Anson, R. W. and Ormeling, F. J., (Ed.) (1993): Basic Cartography for Students and Technicians, Vol.I, International Cartographic Association and Elseiver Applied Science Publishers, London.
3. Dickinson, G. C. (1977) Statistical Mapping and the Presentation of Statistics, Edward Arnold Ltd., London.
4. 4. Monkhouse, F. J. and H. R. Wilkinson, (1971): Maps and Diagrams, Methuen & Co. Ltd., London.
5. Agrawal, N.K.(2006), Essentials of GPS (Second Edition), Book Selection Centre, Hyderabad
6. American Society of Photogrammetry (1983): Manual of Remote Sensing, ASP Palis Church,V.A.
7. Barrett, E.G. and Curtis, L.F. (1992): Fundamentals of Remote Sensing in Air Photo-interpretation, McMillan, New York.
8. Bernhardsen, Tor (2002): Geographical Information Systems: An Introduction, Third Edition, John Wiiey& Sons, Inc., New York.Burrough, Peter A and McDonnell, R.A. (1998): Principles of Geographical Information Systems, Oxford University Press, Mumbai.
9. Campbell. J. (1989): Introduction to Remote Sensing, Guilford, New York.
10. Clarke, Keith C. (1998): Getting Started with Geographic Information Systems, Prentice-Hall Series in Geogl. Info. Science, Prentice-Hall, Inc. N.J.
11. Curran, Paul, J, (1988): Principles of Remote Sensing, Longman, London.
12. Heywood, I.et al (2002): An Introduction to Geological Systems, Pearson Education Limited, New Delhi.
13. Iliffe, J.C (2006), Datums and Map Projections for Remote Sensing, GIS and Surveying, Whittles Publishing, New York.
14. Jonson. R. J. (2003): Remote Sensing of the Environment-An Earth Resources Perspective, Pearson
15. Education Series in Geographical Information Science, Keith C. Clarke (Series editor) Pearson Educators Private Limited. (Singapore), New Delhi.
16. Yeates, M. (1974): An Introduction to Quantitative Analysis in Human Geography, McGraw Hill Book Co., New York.
17. Taylor, P. J. (1977): Quantitative Methods in Geography, Houghton and Miffin Co., Boston.
18. King, L. J. (1969): Statistical Analysis in Geography, Prentice Hall, Inc., Englewood Cliffs, New Jersey.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	0	1	2	1	2	3	1	1	2	1	2	1	2	1
CO 2	1	1	2	2	1	2	2	2	1	2	2	2	3	2
CO 3	2	2	2	1	3	2	0	1	2	1	2	1	1	1
CO 4	1	1	1	0	2	1	1	2	2	1	1	1	0	1
CO 5	0	1	2	2	3	2	2	1	1	2	3	2	2	2
CO 6	1	1	2	1	1	3	1	1	2	1	2	1	2	1

GEO506	Hydro-Meteorology I	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	UG level knowledge of Hydrology and Climatology				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. **Explain** the fundamental principles of surface and sub-surface hydrology.
CO2. **Analyze** different atmospheric phenomenon.
CO3. **Develop** climate models to understand the impact of climate change.
CO4. **Apply r**emote sensing knowledge to study climatic parameters.

Course Content

Unit I: Surface and Sub-surface Hydrology (15 Hours)
Components of hydrologic cycle, Components of the global hydroclimate system, Rainfall–runoff relationship, Flood routing, Kinematic overland flow routing, Kinematic channel modelling, Green Ampt methods, Groundwater flow in confined and unconfined aquifers.

Unit II: Atmospheric Processes (15 Hours)
Hydrostatic pressure law, First law of thermodynamics, Physics of absorption, emission and scattering, Radiative transfer, Adiabatic processes and stability, Atmospheric moisture, Lifting Condensation Level, Oceanic influences on continental hydroclimate: Monsoon flow, Tropical cyclones, ENSO, Pacific and North Atlantic oscillations.

Unit III: Climate Change and Climate Modelling (15 Hours)
Natural causes of climate change, The role of human activity on climate change, Effects of climate change on the hydrological cycle and water resources, Climate sensitivity, Radiative forcing; Climate Models: Energy Balance Models, Two dimensional Statistical Dynamical Models, General circulation models.

Unit IV: Satellite Meteorology (15 Hours)
Indian remote sensing satellites dedicated for Meteorology, Passive microwave technique: Global Precipitation Measurement mission (GPM), Soil moisture and evapotranspiration, Active (radar) microwave techniques: Synthetic aperture radar (SAR), Tropical Rainfall Measuring Mission (TRMM).

Recommended Readings:

1. Applied Hydrology by Ven T. Chow, David R. Maidment, and Larry W. Mays,McGraw Hill International Editions.
2. Engineering Hydrology by K. Subramanya, Tata McGraw Hill Publishing Company, New Delhi.
3. Viessman, Jr., Warren; Gary L. Lewis (2003). Introduction to hydrology (5th ed.). Upper Saddle River, N.J.: Pearson Education
4. Hendriks, Martin R. (2010). Introduction to physical hydrology. Oxford: Oxford University Press.
5. Viessman, Jr., Warren; Gary L. Lewis (2003). Introduction to hydrology (5th ed.). Upper Saddle River, N.J.: Pearson Education
6. Rakhecha, Pukhraj, and Vijay P. Singh. Applied hydrometeorology. Springer Science & Business Media, 2009.
7. Collier, C. G. (2016). Hydrometeorology. John Wiley & Sons.
8. Kevin. Sene. (2017). Hydrometeorology: Forecasting and Applications. Springer.
9. Shuttleworth, W. J. (2012). Terrestrial hydrometeorology. John Wiley & Sons.
10. McGuffie, K., & Henderson-Sellers, A. (2014). The climate modelling primer. John Wiley & Sons.
11. Washington, W. M., & Parkinson, C. (2005). Introduction to three-dimensional climate modeling. University science books.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	1	1	2	1	1	2	3	1	2	1	2	1	2	1
CO 2	1	1	2	2	2	3	2	2	2	2	2	2	3	2
CO 3	1	0	2	1	3	1	2	1	2	1	2	1	1	1
CO 4	0	1	1	1	2	3	1	2	3	1	2	1	0	1
CO 5	1	1	2	2	2	1	2	1	2	2	0	2	2	0
CO 6	1	1	2	1	2	3	3	1	2	1	2	1	2	1

GEO511	Hydro- Meteorology I Lab	L	T	P	C
		0	0	3	2
Pre-requisites/Exposure	UG level knowledge of Hydrology and Climatology				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. **Develop** skill to measure, process and analyze hydrometeorological data.
CO2. **Use** of programming language to read hydrological data.
CO3. **Analyze** hydrological data using different statistical methods.
CO4. **Apply** remote sensing knowledge to study climatic parameters.

Course Content

Unit I: Measurement and Processing of Hydro-meteorological Data (15 Hours)
Instrumentation and measurement of precipitation, evaporation and evapotranspiration, soil moisture, stream discharge; Homogeneity and consistency checking of data, Errors in hydrometeorological data.

Unit II: Statistical Analysis of Hydrological Data (15 Hours)
Introduction to R/Python, Statistical computing and visualization of hydrometeorological data using R/Python, Frequency analysis, Regional flood frequency analysis, Hydrologic time series analysis, Hypothesis Testing, Correlation analysis, Multivariate regression analysis, Autocorrelation, Parameter estimation.

Unit III: Satellite Hydro-meteorology (15 Hours)
Introduction to Google Earth Engine (GEE), Cloud computation of big data: MODIS data product of Land surface temperature, Climatic data, Evapotranspiration, TRMM rainfall data, and Soil moisture data analysis; Applications of satellite data in monsoon variability study.

Unit IV: Laboratory Notebook and Viva voce

Recommended Readings:

1. Arnell, N.W., 1996: Global Warming, River Flows and Water Resources. John Wiley and Sons, Chichester, United Kingdom,
2. Braga, B.P.F. and L.C.B. Molion, 1999: Assessment of the impacts of climate variability and change on the hydrology of South America. In: Impacts of Climate Change and Climate Variability on Hydrological Regimes [van Dam, J.C. (ed.)]. UNESCO, International Hydrology Series, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA,
3. D ö ll , P. and S. Siebert, 2001: Global Modeling of Irrigation Wa t e r Requirements. University of Kassel, Kassel, Germany.
4. David K. Pickard, E. M. Tory (auth.), Ian B. MacNeill, Gary J. Umphrey, A. Ian McLeod (eds.): Advances in the Statistical Sciences, 1986: Stochastic Hydrology: Volume IV Festschrift in Honor of Professor V. M. Joshi's 70th Birthday, Springer Netherlands
5. Ven Chow, David Maidment, Larry Mays, 1988: Applied Hydrology, McGraw-Hill Science
6. James J. Sharp and Peter G Sawden (Auth.), 1984: Basic Hydrology, Butterworth-Heinemann
7. BellieSivakumar (auth.), 2017: Chaos in Hydrology: Bridging Determinism and Stochasticity, Springer Netherlands
8. Nicolas G. Adrien, 2003: Computational Hydraulics and Hydrology: An Illustrated Dictionary, CRC Press
9. Gour-Tsyh (George) Yeh (auth.): 1999, Computational Subsurface Hydrology: Fluid Flows, Springer US
10. Rakhecha, P., & Singh, V. P. (2009). Applied hydrometeorology. Springer Science & Business Media.
11. Collier, C. G. (2016). Hydrometeorology. John Wiley & Sons.
12. Sene, K. (2010). Hydrometeorology-Forecasting and Applications. Dordrecht, Springer.
13. Shuttleworth, W. J. (2012). Terrestrial hydrometeorology. John Wiley & Sons.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	1	1	2	3	2	1	1	1	2	1	2	1	2	1
CO 2	0	1	2	2	2	3	2	2	1	2	2	3	2	2
CO 3	1	2	2	1	2	2	0	1	2	0	2	1	1	1
CO 4	1	1	1	3	2	3	1	2	2	1	1	1	2	1
CO 5	0	1	0	2	2	1	2	1	1	2	2	2	0	2
CO 6	1	1	2	3	2	3	1	1	2	1	2	1	2	1

GEO507	Remote Sensing and GIS I	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	Basic geoinformatics				
Co-requisites	--				

Course Outcomes

On completion of this course, the students will be able to

CO1. Explain the fundamental concepts of remote sensing and GIS.
CO2. Apply the knowledge of image classification techniques to prepare precise land surface information map.
CO3. Analyze the GIS data structure and data transformation.
CO4. Apply the concepts of Database management and GNSS for various geospatial applications

Course Content

Unit I: Remote Sensing (20 Hours)

Basic physics of remote sensing, Resampling theories; Ideas of colour and colour composite creation with remote sensing data, Basic and advanced calculation with images, Generic image classification & advanced classification methods (Segmentation based and SVM) - Object based image classification; Machine learning based classification (random forest), concepts and techniques of accuracy assessment

Unit II: Geographical Information System (20 Hours)
Concept of database and geodatabase; Conversion: Raster to vector and vector to raster, Conversion protocol: American Standard Code for Information Interchange (ASCII) and others, Development of thematic maps, managing attribute table; Geometric measurements & projection (Affine Transformation and Transformation Coefficients), Datum, Ellipsoid, Neighborhood Analysis, Connectivity Analysis.

Unit III: Database management and application of GNSS (20 Hours)
Creation of data tables, file environment, editing and updating of the table in DBMS, development of RDBMS; Concept of Structured Query Languages (SQL), basic commands, SQL query in database, query by location and attribute; Basics of Geopositioning: Satellite constellation, Pseudo Range Measurement, Phase Difference Measurement, DOP, GNSS using different datum, Sources of GNSS errors, GNSS and GIS integration.

Recommended Readings:
1. Bhatta B., 2011: Remote Sensing and GIS, Oxford Publisher.
2. Campbell J. B., 2007: Introduction to Remote Sensing, Guildford Press.
3. Jensen J. R., 2004: Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall.

4. Joseph, G. 2005: Fundamentals of Remote Sensing, United Press India.
5. Lillesand T. M., Kiefer R. W. and Chipman J. W., 2004: Remote Sensing and Image Interpretation, Wiley. (Wiley Student Edition).
6. Nag P. and Kudra, M., 1998: Digital Remote Sensing, Concept, New Delhi.
7. Rees W. G., 2001: Physical Principles of Remote Sensing, Cambridge University Press.
8. Singh R. B. and Murai S., 1998: Space-informatics for Sustainable Development, Oxford and IBH Pub.
9. Satheesh Gopi (2005). Global Positioning System: Principles and Applications. McGraw Hill Publishers.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	1	1	2	1	2	2	3	1	2	1	2	1	2	1
CO 2	0	0	2	2	2	2	2	2	2	2	2	2	2	2
CO 3	1	2	2	1	2	3	2	1	2	1	3	1	1	1
CO 4	1	1	1	1	2	2	2	2	2	1	0	1	2	1
CO 5	1	1	0	2	2	3	2	1	2	2	2	2	2	2
CO 6	1	1	2	1	2	2	3	1	2	1	2	1	2	0

GEO512	Remote Sensing And GIS I Lab	L	T	P	C
Version 1.0		0	0	3	2
Pre-requisites/Exposure	Basic geoinformatics				

Co-requisites	-

Course Outcomes

On completion of this course, the students will be able to:

CO1. **Explain** principles, techniques and methods of geospatial data collection, data visualization, data preparation and data interpretation techniques with a focus on land-use and land-cover classification and change detection.
CO2. **Draw** thematic maps using suitable spatial analyst tools in GIS environment.
CO3. **Explain** the methods of Geoportal application, VGI and Mobile GIS and its societal application using suitable tools.

Course Content

Unit I: Remote Sensing (15 Hours)
Remote sensing and geospatial data collection – techniques; image enhancement and image rectifications; generic image classification & advanced classification methods (Segmentation based and SVM) - object based image classification and machine learning based classification; accuracy assessment and change detection of multi-temporal data

Unit II: Geographical Information System (15 Hours)
Spatial database creation, managing Geodatabase, GIS data conversion, raster calculation, spatial analysis through vector overlay, spatial queries, neighborhood analysis and connectivity analysis

Unit III: Database management and application of GPS (15 Hours)
Preparation of data tables, file environment, editing and updating of the table in DBMS, preparation of RDBMS; SQL based query in database, query by location and attribute; GPS and its initial setting, point data collection with GPS using different datum, area measurement using GPS, post processing of GPS data, GPS and GIS integration and output preparation.

Unit IV: Laboratory Notebook and Viva voce

Recommended Readings:
1. Bhatta B., 2011: Remote Sensing and GIS, Oxford Publisher.
2. Campbell J. B., 2007: Introduction to Remote Sensing, Guildford Press.
3. Jensen J. R., 2004: Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall.
4. Joseph, G. 2005: Fundamentals of Remote Sensing, United Press India.
5. Lillesand T. M., Kiefer R. W. and Chipman J. W., 2004: Remote Sensing and Image

Interpretation, Wiley. (Wiley Student Edition).
6. Nag P. and Kudra, M., 1998: Digital Remote Sensing, Concept, New Delhi.
7. Rees W. G., 2001: Physical Principles of Remote Sensing, Cambridge University Press.
8. Singh R. B. and Murai S., 1998: Space-informatics for Sustainable Development, Oxford and IBH Pub.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	1	1	2	2	2	2	1	1	2	1	2	1	2	1
CO 2	1	0	2	2	2	2	2	2	1	2	2	2	2	2
CO 3	1	2	2	2	2	2	1	1	2	1	2	1	1	1
CO 4	1	1	1	3	2	3	1	2	2	1	1	0	2	1
CO 5	0	1	2	2	2	1	2	1	1	2	2	2	2	0
CO 6	1	1	2	1	2	3	1	1	2	1	2	1	2	1

GEO513	Internship	L	T	P	C
					2
Pre-requisites/Exposure	Undergraduate knowledge of Geography				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to:

CO1. Gain practical exposure to industry-standard geospatial tools and practices.
CO2. Apply theoretical knowledge to solve real-world geographical problems.
CO3. Collaborate with professionals to develop effective teamwork and communication skills.
CO4. Analyze industry challenges and propose innovative solutions.
CO5. Develop technical reports and presentations based on industry project findings.
CO6. Reflect on the learning experience to enhance professional competencies.

Course Content

An Industry Interaction Report to be prepared and submitted individually by each student, based on actual industrial interaction and visits, done jointly or in groups with other students.

Word Limit = 4000 (maximum) excluding Tables and Appendix (Computer typed, Line Spacing =
1½, Arial Narrow / Times New Roman / Helvetica 10 / 11/ 12)

Time allotted for Viva Voce / Examinee = 15 minutes (maximum)

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	3	3	3	2	2	3	2	3	3	3	3	3
CO 2	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

GEO514	Dissertation I	L	T	P	C
					4
Pre-requisites/Exposure	In depth knowledge on masters level special paper				
Co-requisites	English writing and communication skill				

Course Outcomes

On completion of this course, the students will be able to:

CO1. Review literature for research work and identify gaps.
CO2. Formulate research questions and objectives for a dissertation.
CO3. Document the literature review and summarize research findings.
CO4. Present the literature review and methodology for dissertation research.
CO5. Critically assess the relevance of literature to the research topic.
CO6. Synthesize information for a comprehensive research proposal.

Course Content

Unit I: Review of Literature & Identifying the Research Questions & Objective of the study (15 Hours)

Unit II: Methodology Selection (15 Hours)

Unit III: Preliminary data analysis (15 Hours)

Unit IV: Documentation and Presentation on Literature review, Research Data and Methodology and Viva (15 Hours)

Recommended Readings:
Good research articles published from reputed journals on their specific research domain.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	3	3	2	2	2	2	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO 3	3	3	3	3	2	2	2	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

SEMESTER: IV

GEO515	Advanced Quantitative Techniques Lab	L	T	P	C
		0	0	6	4
Pre-requisites/Exposure	Undergraduate level Geography knowledge				
Co-requisites					

Course Outcomes

On completion of this course, the students will be able to:

CO1. **Calculate** spatial statistics, probability and matrix algebra.
CO2. **Prepare** model based on multivariate data and their interpretation.
CO3. **Apprise** factor analysis, both explanatory and confirmatory.
CO4. **Develop** an idea and technical skill to perform structural analysis of data.
CO5. **Create** interpolated surface based on spatial data.

Course Content

Unit I: Spatial Statistics (30 Hours)
Computation of shape (natural and man-made) indices; Probability of Events / Occurrences (Normal, Binomial, Poisson); Spatial relationships: Join Count Statistics (Free Sampling and Non – free sampling methods), Moran's Coefficient and Hot spot analysis.

Unit II: Multivariate Data Analysis (30 Hours)
Regression theory; Multiple Linear Regression; Multiple and partial Correlation coefficients; Stepwise regression; MANOVA, Principles and techniques of Matrix Algebra; Factor Analysis (confirmatory and exploratory); Path Analysis; Structure Equation Modelling;

Unit III: Spatial Relationship and interdependence (30 Hours)
Measures of interdependence: Cluster Analysis (CA), Multidimensional Scaling, Discriminant Analysis (DA); Spatial Surface Analysis, Inverse Distance Averaging, splines, Krigging and Co-Krigging. Variograms.

Unit IV: Laboratory Notebook and Viva voce.

Recommended Readings:

1. Alvi, Z. 1995: Statistical Geography-Methods & Application, RawatPublications,Jaipur.
2. Ashis Sarkar, Quantitative Analysis in Geography, Blackswan Publishers.
3. Clark, W.A.V. and Hosking, P.L. 1986: Geographical Methods for Geographers, John Wiley and Sons,New York.
4. Croxton, F.E., Cowden, D.J. & Klein, S 1969: Applied General Statistics, PrenticeHall of India Pvt. Ltd.,New Delhi.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	1	1	2	1	1	2	3	1	2	1	2	1	2	1
CO 2	1	1	2	2	2	3	2	2	2	2	2	2	3	2
CO 3	1	0	2	1	3	1	2	1	2	1	2	1	1	1
CO 4	0	1	1	1	2	3	1	2	3	1	2	1	0	1
CO 5	1	1	2	2	2	1	2	1	2	2	0	2	2	0
CO 6	1	1	2	1	2	3	3	1	2	1	2	1	2	1

GEO516	Environmental Geography II	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	Graduate level Environmental Geography knowledge, PG level Advanced Environmental Geography				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. **Analyze** the human impacts on the environmental focusing the social and historical context of environmental issues linking between human and natural systems.
CO2. **Explain** the various types of social hazard, and social movements to protect the environment.
CO3. **Analyze** the various aspects of Environmental Impact Assessment and Environmental Management especially in urban ecosystem.
CO4. **Justify** the role of various environmental policies and management strategies to protect the environment, in particular, focusing Indian context.

Course Content

Unit I: Anthropogenic Aspects (15 Hours)
Environment and Development: Utilization and Conservation of Renewable Resources, Recycling of
Materials, Afforestation, Biodiversity and Biotechnology, Population Growth, Economic Development and Environmental Conservation with Special Reference to Third World Countries, Basic Principles of Spaceship Earth---Ecosystem Balance, Agricultural and Industrial Planning and Environment

Unit II: Social hazards and Human Impacts (15 Hours)
Social Hazards: Poverty and Famine, Crime and Human Trafficking; National Food Security Bill in India 2013, Population, Health and Environment in India, Confronting Environmental issues: Social Movements in India*:* Bisnoi, Chipko, Silent valley and Narmada; Man-animal Conflict in Forest-society Interface of Sundarbans

Unit III: Environmental Impact Assessment and Environmental Management (15 Hours)
Environmental Impact Assessment, Environmental Audit, Environmental Management Plan; Case Studies of East Calcutta Wetland and Chilika; Sustainable Development, Peri- urban inference of Indian cities, Sustainable cities, Sustainable consumption, Urban Environmental Management: Local Self-governance and Community Action; Significance of Slum Development and Ecotourism; Solutions for a cultivated planet

Unit IV: Environmental Policy and Management in India (15 Hours)

Environmental Ethics, Laws and Policies: Concept and development of environmental philosophy, Ecocentrism and Anthropocentrism, the land ethic (Aldo Leopold), Gaia concept, Eco-feminism., Formal and non-formal environmental education, Tbilisi conference, environmental awareness; Landscape ecology and ethno-ecology, environmental stewardship, Collective action, Property rights and Participatory Management of forests in India, Environmental Laws in India: Legal Intervention, Government Policy, Institutional set-up and Role of NGOs in Environmental Management in India, Bhopal Gas Tragedy and Ganga Action Plan.

Recommended Readings:

1. Anderson 1985: Ecology for Environmental Science.
2. Chapman, J.L. and Reiss, M.J. 1992: Ecology Principles and Applications, Cambridge University Press, Cambridge.
3. Daji, J.A., Kadam, J.R. and Patil, N.D. 1996: A Textbook of Soil Science, Media Promoters and Publishers Pvt Ltd, Mumbai.
4. Kormondy, E. J. 1991: Concepts of Ecology.
5. Nebel, J.B. 1981: Environmental Science, Prentice Hall, New York.
6. Odum, F.P. 1971: Fundamentals of Ecology, W.B. Sanders, Philadelphia.
7. Robinson, H. 1982: Biogeography.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	1	1	2	3	2	1	1	1	2	1	2	1	2	1
CO 2	0	1	2	2	2	3	2	2	1	2	2	3	2	2
CO 3	1	2	2	1	2	2	0	1	2	0	2	1	1	1
CO 4	1	1	1	3	2	3	1	2	2	1	1	1	2	1
CO 5	0	1	0	2	2	1	2	1	1	2	2	2	0	2
CO 6	1	1	2	3	2	3	1	1	2	1	2	1	2	1

GEO521	Environmental Geography Lab II	L	T	P	C
		0	0	3	2
Pre-requisites/Exposure	Environmental Geography knowledge, Working knowledge in Remote Sensing and GIS software				
Co-requisites	Soil chemistry knowledge and instrument handling				

Course Outcomes

On completion of this course, the students will be able to

CO1. **Apply** the knowledge of Remote Sensing and GIS for urban built-up environmental mapping.

CO2. **Analyze** the soil properties, characteristics and pollutants through laboratory testing and field measurement.

CO3. **Prepare** soil maps using geospatial techniques from field collected data and secondary data.

Course Content

Unit I: Mapping the Built Environment (using RS-GIS techniques) (15 Hours)

Mapping of Urban Land Use/Land Cover (LULC) and Urban Sprawl, Detection of changes in the Urban Environment with the help of: NDVI (Normalized Differential Vegetation Index), NDWI (Normalized Differential Water Index), NDBal (Normalised Difference Bareness Index), Estimation of Land surface temperature (LST) and Emissivity through field survey, Mapping of through remote sensing and establishing relationship between different LULC and LST

Unit II: Laboratory Techniques to Analyze Soil Characteristics (15 Hours)

Hygroscopic moisture and Soil texture by Mechanical analysis, Soil pH and organic matter carbon, Nitrate and Phosphate, Salinity and Alkalinity

Unit III: Field Works and Mapping Laboratory Techniques to Detect Soil Pollution (15 Hours)

Identification and study of Soil in field, Preparation of Soil Maps, Mapping and representation of data with the help of GIS software, Identification of relationship between Land use and soil characteristics

Unit IV: Laboratory Note Book and Viva-voce

Recommended Readings:

1. William J. Sutherland (2006): Ecological Census Techniques Edited by Cambridge 2nd edition
2. Lagacherie Philippe, McBratney Alex and Voltz Marc(2006) : Digital Soil Mapping :An Introductory Perspective, Elsevier
3. Scull, P.; J. Franklin, O.A. Chadwick & D. McArthur (June 2003). Predictive soil mapping - a review.
4. Progress in Physical Geography, Sage Publications.
5. Monkhouse, F.J. 1971: Maps and Diagrams, Methuen, London
6. Singh, R.L. and Singh, R.P.B. 1992: Elements of practical Geography.
7. 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.
8. Basu, R. and Bhaduri, S. ed, 2007: Contemporary Issues and Techniques in Geography, Progressive Publishers, Kolkata.
9. Gupta, K. K. and Tyagi, V. C. (1992): Working with maps, Survey of India Publication, Dehradun

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	1	1	2	1	2	2	3	1	2	1	2	1	2	1
CO 2	0	0	2	2	2	2	2	2	2	2	2	2	2	2
CO 3	1	2	2	1	2	3	2	1	2	1	3	1	1	1
CO 4	1	1	1	1	2	2	2	2	2	1	0	1	2	1
CO 5	1	1	0	2	2	3	2	1	2	2	2	2	2	2
CO 6	1	1	2	1	2	2	3	1	2	1	2	1	2	0

GEO517	Applied Geomorphology and Hazard II	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	UG level knowledge of Geomorphology and Hazard				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. **Develop** an idea about the mechanism, causes, impact and management options of landslide, flood, river bank erosion, soil erosion, coastal erosion, tsunami, cyclonic storms.

CO2. **Explain** the concept the vulnerability and risk and the parametric approaches for hazard zonation.

CO3. **Assess** the vulnerability of soil erosion, river bank erosion, flood hazard, coastal erosion, tsunami, cyclone and sea level rise.

CO4. **Apply** geomorphological knowledge in Environmental Impact Assessment and Environmental Management Planning.

Course Content

Unit I: Landslide and Soil erosion hazards (15 Hours)

Mechanism, types and causes of landslides; Methods for landslide investigation, Landslide hazard assessment; Controlling measures, Physical bases of erosion: Water erosion; Aeolian erosion, Estimation of Soil Erosion, Management of soil erosion.

Unit II: Fluvial hazards (15 Hours)

River bank erosion - causes, mechanism and remedial measures, Causes and impact of flood, Assessment of flood, Flood hazard zonation, Management of flood.

Unit III: Coastal Hazards (15 Hours)

Mechanism and causes of coastal erosion; Methods of coastal erosion management, Problems and impacts of Dune Encroachment; Dune encroachment management, Mechanism and causes of tsunami; Management and Early warning systems, Formation, types and causes of Cyclone; prediction and management planning.

Unit IV: Vulnerability and Risk assessment (15 Hours)

Sea level rise and its impacts on coastal geomorphology, Concepts of Vulnerability and Risks, Parametric approaches for Hazard zonation, Geomorphology and Environmental Impact Assessment; Environmental Impact Scheme (EIS) and Environment Management Planning (EMP).

Recommended Readings:

1. Bull, William B. (1991): Geomorphic Responses to Climate Change. The Blackburn Press.
2. Ollier, C. D.: Weathering.
3. Tripathi, R. P. and Singh, H.P. (1993): Soil Erosion and Conservation. Willey Eastern Limited.
4. Singh, S., Sharma, H. S. and De, S. K. (2004): Geomorphology and Environement. Acb Publications, kolkata .
5. Thornbury, W. D. (1986): Principles of Geomorphology. Willey Eastern Limited.
6. Zaruba, Q. and Mencl, V. (1976): Landslides and their control. Elsevier Science.
7. Raghunath, H.M. (2006) : Hydrology. New Age International Ltd.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	0	1	2	1	2	3	1	1	2	1	2	1	2	1
CO 2	1	1	2	2	1	2	2	2	1	2	2	2	3	2
CO 3	2	2	2	1	3	2	0	1	2	1	2	1	1	1
CO 4	1	1	1	0	2	1	1	2	2	1	1	1	0	1
CO 5	0	1	2	2	3	2	2	1	1	2	3	2	2	2
CO 6	1	1	2	1	1	3	1	1	2	1	2	1	2	1

GEO522	Applied Geomorphology and Hazard Lab II	L	T	P	C
		0	0	3	2
Pre-requisites/Exposure	UG level knowledge of Geomorphology and Hazard				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. Analyze morphological data using lab based, field based and computer based techniques.

CO2. Apply hydrological and morphological knowledge to measure, process and analyze soil and water related data.

CO3. Apply geomorphological knowledge to measure, process and analyze topographical data and to estimate geomorphological hazard index.

CO4. **Apply** remote sensing and GIS techniques for morphological mapping.

Course Content

Unit I: Laboratory based (15 Hours)

Grain size analysis, Determination of soil pH and organic carbon and other major elements, Determination of soil and water pollutants, Atterberg limits.

Unit II: Field based (15 Hours)

Estimation of soil loss along slope, Bank erosion estimation by using Bank Erosion Hazard Index Method, Contouring of a slope by Total Station, Soil moisture determination by Tensiometer.

Unit III: Computer based (15 Hours)

Use of GPS for collecting Ground Control Point and Geo-referencing of map with the help of GCP, LULC analysis, Spatio- temporal change detection and Matrix calculation, Determination of Soil loss and Sediment Yield by using computer aided programmes, Image enhancement and analysis.

Unit IV: Laboratory Note Book and presentation

Recommended Readings:

1. Department of Agriculture. Field Book for Describing and Sampling Soils: National Soil Survey Center Natural Resources Conservation Service U.S., 3rd Version.
2. Soil Survey Division Stuff. Soil Survey Manual. Published by- Department of Agriculture, U.S.
3. G. M. Coen: Soil survey handbook. Technical Bulletin 1987-9E. Published by Agriculture, Canada.
4. Lagacherie Philippe, McBratney Alex and Voltz Marc. Digital Soil Mapping. An Introductory Perspective, Elsevier.
5. S. Wieprecht, S. Haun, K. Weber, M. Noack and Kristina Terheiden. River Sedimentation: Proceedings of the 13th International Symposium on River Sedimentation (Stuttgart, Germany, 19-22 September, 2016)
6. M. Promisky. A. Stockman. S. Zeller and D. Stimberg. River Space design. Planning Strategies, Methods and Projects for Urban Rivers.
7. S. V. Estopinal. A Guide to Understanding Land Survey. 3rd edition.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	1	1	2	1	1	2	3	1	2	1	2	1	2	1
CO 2	1	1	2	2	2	3	2	2	2	2	2	2	3	2
CO 3	1	0	2	1	3	1	2	1	2	1	2	1	1	1
CO 4	0	1	1	1	2	3	1	2	3	1	2	1	0	1
CO 5	1	1	2	2	2	1	2	1	2	2	0	2	2	0
CO 6	1	1	2	1	2	3	3	1	2	1	2	1	2	1

GEO518	Urban and Regional Planning II	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	Undergraduate level knowledge of urban geography, regional planning and development and settlement geography				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. **Explain** the principles for model formulation with an emphasis on linear model, gravity model, population forecasting model and urban land-use and transportation models.

CO2. **Relate** the features and elements of urban landscape and urban aesthetic planning with landscape architecture, design and evolution of technology, standards and regulatory controls.

CO3. **Examine** role of urban infrastructure and urban governance to address the needs of sustainable planning for smart city.

Course Content

Unit I Modelling in Planning (10 Hours)

Role of Models in Planning: Systems view of planning and use of quantitative models in planning, principles for designing and model formulation, Evaluation of Models and its application in planning: Linear models, gravity models, population forecasting model, regional transportation models and issues, Contemporary cities and critical perspectives – inclusion versus exclusion, urban space and gender sensitive planning; need for planning and social justice.

Unit II: Urban Landscape (25 hours)

Urban aesthetics: terms and concepts in urban aesthetics, content and development of an urban aesthetic plan, urban designing schemes and evaluation, Landscape designing: purpose and concerns for landscape assessment, man – landscape relationship over centuries – landscape architecture of western and oriental regions (Egyptian, Babylonian, Greek, Roman, Italian, French, English, Persian, Moghul, Indian, Chinese, Japanese), modern and contemporary trend, Urban forms and designing: standard and regulatory control on urban design and forms, impact of technology and role of urban designing in planning process, Landscape assessment and evaluation: Open space and landscape planning, planning consideration with new projects like expressway, river roads, abandoned quarries, tree plantation and street furniture and utility.

Unit III: Infrastructure, Governance and Smart City (25 Hours)

Urban infrastructure – elements of infrastructure, land requirement and rights; Urban renewal and rehabilitation; concept in India and in developing countries, policies, legislation, comparative evaluation and critical appraisal with case studies, Urban governance and Urban legislation: planning and development; Town and country planning act, Land acquisition Act, Zoning of urban land use (slum clearance, housing, landscape and traffic), Urban land ceiling and regulation; urban conservation and restoration; Urban Environmental Laws and concerns; Technology and E-governance, Sustainable urban planning: Theory and background of sustainable urban planning, Three E's of sustainability and urban development debate, Sustainable planning for different scales and emergence of new urbanism and smart growth, Smart cities: Concepts, typologies approaches and characteristics, smart city planning in developed and developing economy – critical evaluation

on economic and financial viability; Smart city mission in India, Future urbanism and vision

Recommended Readings:

1. Abdul Razak, M. (2004) Mobility patterns and strategies used for spatial access to work of the squatter households in the peri-urban Delhi, India. Paper presented at the International
2. Abu-Lughod, J. and Hay, R. Jr. (1977): Third World Urbanisation, Maarouta Press.
3. Abu-Lughod, J. L. (1999) New York, Chicago, LosAngeles: America's Global Cities. Minneapolis, MN: University of Minnesota Press.
4. AIILSG (All India Institute of Local Self-Government) 2004) Transforming Mumbai into a world class city. AIILSG, Mumbai.
5. Allen J. Scott (ed.), (2001): Global City Regions, Trends, Theory & Policy, Oxford University Press.
6. Allwinkle, S., & Cruickshank, P. (2011). Creating smart-er cities: An overview. Journal of Urban Technology, 18(2), 1–16.
7. Amin, A., & Thrift, N. (2002). Cities: Reimagining the Urban, London: Polity, Bates, J. (2012). ''This is what modern deregulation looks like'': Co-optation and contestation in the shaping of the UK's Open Government Data Initiative. The Journal of Community Informatics, 8(2).
8. Banerjee-Guha, S. (1997) Spatial Dynamics of International Capital. Hyderabad: Orient Longman.
9. Banerjee-Guha, S. (2002a) Metropolitan dominance and regional disparity in India: observations from relevant planning measures of Japan, Visiting Research Fellow Series No. 358, Instituteof Developing Economics, Japan External Trade Organization.
10. Banerjee-Guha, S. (2002b) Shifting cities: urban restructuring in Mumbai, Economic and Political Weekly, pp. 121–128.
11. Banerjee-Guha, S. (2008) Space relations of global capital and significance of new economic enclaves: SEZs in India, Economic and Political Weekly, 43(47), pp. 51–61.
12. Batty, M., Axhausen, K. W., Giannotti, F., Pozdnoukhov, A.,Bazzani, A., Wachowicz, M., et al. (2012). Smart cities of the future. European Physical Journal Special Topics, 214(1), 481–518.
13. Beaverstock, J. V., Smith, R. G. and Taylor, P. J.(1999) A roster of world cities, Cities, 16, pp. 445–458.
14. Bowker, G., & Star, L. (1999). Sorting things out: Classification and Its consequences. Cambridge: MIT Press.
15. Boyd, D.,&Crawford, K. (2012). Critical questions for big data, Information, Communication and Society, 15(5), 662–679.
16. Cadene, P. and Marius-Gnanou, K. (2004) Peri urban dynamics: around the Indian metropolises: some findings from the Chennai experience, Paper presented at the International workshop on 'Peri-urban Dynamics',National University of Singapore, December.
17. Carter, H (1972): The Study of Urban Geography, Edward Arnold.
18. CIDCO (City and Industrial Development Corporation of Maharashtra) (1973) A report on the development of New Bombay, Bombay
19. Clarke, D. (1982): Urban Geography: An Introductory Guide, Groom Helm.
20. D'Monte, D. (2002) Ripping the Fabric: The Decline of Mumbai and Its Mills. New Delhi: Oxford University Press.
21. David Harvey (1985): The Urbanization of Capital, John Hopkins University Press.
22. Dea´k, C. and Schiffer, S. (2007) Sa˜o Paulo: the metropolis of an elite society, in: K. Segbers (Ed.) The Making of Global City Regions: Johannesburg, Mumbai/Bombay, Sa˜o Paulo, and Shanghai, pp. 85–112. Baltimore, MD: Johns Hopkins University Press.
23. Dodge, M., &Kitchin, R. (2004). Flying through code/space: The real virtuality of air travel. Environment and Planning A, 36(2), 195–211.

24. Dodge, M., &Kitchin, R. (2005). Codes of life: Identification codes and the machine-readable world. Environment and Planning D: Society and Space, 23(6), 851–881.
25. Dodge, M., &Kitchin, R. (2007a). The automatic management of drivers and driving spaces. Geoforum, 38(2), 264–275.
26. Dodge, M., &Kitchin, R. (2007b). Outlines of a world coming in existence': Pervasive computing and the ethics of forgetting, Environment and Planning B, 34(3), 431–445.
27. Dupont, V. (2004) Peri-urban dynamics: population, habitat and environment on the peripheries of large Indian metropolises. Introductory paper at the International Workshop on 'Periurban Dynamics', National University of Singapore, December.
28. Dupont, V. (2005) Peri-urban dynamics: population, habitat and environment on the peripheries of large Indian metropolises: review of concepts and general issues. Occasional Paper No. 14, Centre de Sciences Humaines, New Delhi.
29. Dutton, W. H., Blumler, J. G., & Kraemer, K. L. (1987). Wired cities: Shaping future communication. New York: Macmillan.
30. Edward Soja (2000): Postmetropolis, Critical Studies of cities and Regions, Blackwell Publisher Ltd.
31. F. S. Hudson," Geography of Settlements", and Evans Ltd. Estover, Plymouth PL 6 7 PZ UK
32. G. K. Bandopadhyaya , "Text Book of Town Planning".
33. G. P. Chapman, A.K. Dutt and R.W. Bradnock (ed.) (1999): Urban growth & Development in Asia, Vol.2: Living in the Cities, Ashgate Publishing Ltd.
34. Gugler. J. (ed.)(1988): The Urbanisation of the Third World, O.U.P
35. Haque, U. (2012). What Is a City that It Would Be 'Smart'? Volume #34: City in a Box. http://volumeproject.org/blog/ 2012/12/21/volume-34-city-in-a-box
36. Harvey, D.(1973): Social Justice and the City, Arnold
37. King A. D. (1990): Global Cities, Routledge.
38. Latham, D. McCormack, K. McNamara, D. McNeill (2009): Key Concepts in Geography, Sage.
39. Marcuse, P. and Kempen, R.V. (eds.),(2000): Globalizing Cities: A New Spatial Order, Blackwell.
40. Markusen, A.R., et al. (1991): Second Tier Cities- Rapid Growth beyond the Metropolis, University of Minnesota Press.
41. Peter Hall, "Urban and Regional Planning".
42. Pieterse E, (2008): City Futures, Confronting the Crisis of Urban Development, Zed Books Ltd, London and New York.
43. Sassen, S. (1991): The Global City, Princeton University Press.
44. Short, J. R. (1996): The Urban Order, Basil Bleckwell.
45. Simmonds, R. and Hack, G. (2000): Global City Regions, Spon Press.
46. Smith, N. (1996): The New Urban Frontier, Routledge

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	1	1	2	3	2	1	1	1	2	1	2	1	2	1
CO 2	0	1	2	2	2	3	2	2	1	2	2	3	2	2
CO 3	1	2	2	1	2	2	0	1	2	0	2	1	1	1
CO 4	1	1	1	3	2	3	1	2	2	1	1	1	2	1
CO 5	0	1	0	2	2	1	2	1	1	2	2	2	0	2
CO 6	1	1	2	3	2	3	1	1	2	1	2	1	2	1

GEO523	Urban and Regional Planning Lab II	L	T	P	C
		0	0	3	2
Pre-requisites/Exposure	Undergraduate level knowledge of field studies, data collection techniques and analysis				
Co-requisites	Familiar with the GIS, RS and statistical software				

Course Outcomes

On completion of this course, the students will be able to

CO1. **Solve** critical spatial problems of population and infrastructure distribution and forecasting using suitable RS and GIS environment.
CO2. **Analyze** resource based urban problems using suitable geospatial modelling.
CO3. **Report** application of decision support system with a focus on contemporary urban issues.

Course Content

Unit I: Population-Infrastructure: Critical Problems and Solutions (15 Hours)

Utilization of space technology for grass root level planning and governance; Spatial distribution of select elements like population – population forecasting models, the cohort- survival model, Migration model; Location-Allocation Problems – spatial distribution of basic infrastructural facilities (education/health/finance) and deficiency – critical evaluation– practical solutions

Unit II: Geospatial Modelling (15 hours)

Site suitability modelling using GIS; Land use and transportation forecasting and modeling; Retail and local service activity location models; hotspot modelling and spatio-temporal analysis of urban events.

Unit III: Decision-support in urban planning with some case studies (15 hours)

Concept of Decision Support Systems (DSS, SDSS and MDCA); Introduction to decisions making models (qualitative, quantitative and hybrid) and its application in urban studies; Mini project and case studies on solid and municipal waste management/educational services and population accessibility/market resource and utility mapping/health services and utility mapping/urban climate and human comfortability/ hazard and disaster management.

Unit IV: Laboratory Notebook and Viva voce

Recommended Readings:

1. Robinson, A. H. and Others (1995): Elements of Cartography, VI Edition, John Wiley & Sons, New York.
2. Anson, R. W. and Ormeling, F. J., (Ed.) (1993): Basic Cartography for Students and Technicians, Vol.I, International Cartographic Association and Elseiver Applied Science Publishers, London.
3. Dickinson, G. C. (1977) Statistical Mapping and the Presentation of Statistics, Edward Arnold

Ltd., London.
4. Monkhouse, F. J. and H. R. Wilkinson, (1971): Maps and Diagrams, Methuen & Co. Ltd., London.
5. Agrawal, N.K. (2006), Essentials of GPS (Second Edition), Book Selection Centre, Hyderabad
6. American Society of Photogrammetry (1983): Manual of Remote Sensing, ASP PalisChurch,V.A.
7. Barrett, E.G. and Curtis, L.F. (1992): Fundamentals of Remote Sensing in Air Photo-interpretation, McMillan, New York.
8. 10. Bernhardsen, Tor (2002): Geographical Information Systems: An Introduction, Third Edition, John
9. Wiiey& Sons, Inc., New York.Burrough, Peter A and McDonnell, R.A. (1998): Principles of Geographical Information Systems, Oxford University Press, Mumbai.
10. Campbell. J. (1989): Introduction to Remote Sensing, Guilford, New York.
11. Clarke, Keith C. (1998): Getting Started with Geographic Information Systems, Prentice-Hall Series in Geogl. Info. Science, Prentice-Hall, Inc. N.J.
12. Curran, Paul, J, (1988): Principles of Remote Sensing, Longman, London.
13. Heywood, I.et al (2002): An Introduction to Geological Systems, Pearson Education Limited, New Delhi.
14. Iliffe, J.C (2006), Datums and Map Projections for Remote Sensing, GIS and Surveying, Whittles Publishing, New York.
15. Jonson. R. J. (2003): Remote Sensing of the Environment-An Earth Resources Perspective, Pearson Education Series in Geographical Information Science, Keith C. Clarke (Series editor) Pearson Educators Private Limited. (Singapore), New Delhi.
16. Yeates, M. (1974): An Introduction to Quantitative Analysis in Human Geography, McGraw Hill Book Co., New York.
17. Taylor, P. J. (1977): Quantitative Methods in Geography, Houghton and Miffin Co., Boston.
18. King, L. J. (1969): Statistical Analysis in Geography, Prentice Hall, Inc., Englewood Cliffs, New Jersey.
19. Hammond, R. and McCullagh, P.S. (1974): Quantitative Techniques in Geography: An Introduction, Oxford University Press, London.
20. Mahmood Aslam (1977): Statistical Methods in Geographical Studies, Rajesh Publications, New Delhi.
21. Cole, J.P. and King, C.A.M.(1968): Quantitative Geography, John Wiley and Sons, London.
22. Berry, B.J.L. and Marble, D.F. (1968): Spatial Analysis – A reader in statistical Geography, Prentice Hall, Englewood Cliffs, New Jersey.
23. Levin, J. (1973): Elementary Statistics in Social Research, Harper and Row, New York.
24. Norcliff, G. B. (1982), Inferential Statistics for Geographers, Hutchinson, London.
25. Wilson A. G. and Bennet, R. J., (1985), Mathematical Methods in Geography and Planning, John Wiley and Sons, New York.
26. Cressie, N., (1991), Statistics for Spatial Data, John Wiley and sons, New York.
27. Wicox, P.R. (2003), Applying Contemporary Statistical Techniques, Academic Press, Amsterdam
28. Crang M. and Cook, I. 2007, Doing Ethnographies, Sage.
29. Rogerson P.A. (2010), 3rd Ed. Statistical Methods for Geography, a Students Guide, Sage.
30. Vallentine G. Clifford N. (2010), Key Methods in Geography, Sage
31. Berry, B.J.L. and Marble, D.F. (1968): Spatial Analysis – A reader in statistical Geography, Prentice Hall, Englewood Cliffs, New Jersey.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	1	1	2	1	2	2	3	1	2	1	2	1	2	1
CO 2	0	0	2	2	2	2	2	2	2	2	2	2	2	2
CO 3	1	2	2	1	2	3	2	1	2	1	3	1	1	1
CO 4	1	1	1	1	2	2	2	2	2	1	0	1	2	1
CO 5	1	1	0	2	2	3	2	1	2	2	2	2	2	2
CO 6	1	1	2	1	2	2	3	1	2	1	2	1	2	0

GEO519	Hydro- Meteorology II	L	T	P	C
Version 1.2		4	0	0	4
Pre-requisites/Exposure	UG level knowledge of Hydrology and Climatology				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. **Develop** models to study different hydrological parameters.
CO2. **Analyze** the causes and consequences of flood and draught.
CO3. **Apply** different flood estimation and forecasting methods.
CO4. **Learn** about different weather forecasting methods.

Course Content

Unit I: Hydrological Modelling (15 Hours)
Hydrologic models and their classification, Review of poplar hydrological models, Modelling of hydrologic processes: infiltration, surface runoff, and evapotranspiration, Model calibration and validation, Uncertainty in model simulation.

Unit II: Flood and Drought (15 Hours)
Floods: Types of floods, Causes of floods, Floods in Indian Rivers, Flood control methods – structural and non-structural measures, Flood zonation.

Drought: Types of Drought, Causes of Droughts, Drought indices, Droughts in India, Modelling the occurrence of drought, Strategies for drought protection and mitigation.

Unit III: Flood Estimation and forecasting (15 Hours)
Flood estimation: rational method, empirical formulae and unit hydrograph method; Flood frequency estimation, Regional Flood Frequency Analysis, Estimation of Design Flood; Flood forecasting techniques: modelling approach and forecasting system.

Unit IV: Meteorological Forecasting (15 Hours)
Forecasting techniques: Nowcasting, Numerical weather prediction, Statistical method, Medium range forecasting, Seasonal forecasting.

Recommended Readings:

1. Atmospheric science – An Introductory Survey, J.M. Wallace and P.V. Hobbs, 2nd Edition, Academic Press, London, 2006.
2. An Introduction to Atmospheric Thermodynamics, A.A. Tsonis, 2nd Edition, Cambridge University Press, Cambridge, 2007
3. Climate Change 2007 – The Physical Science Basis, IPCC Fourth Assessment Report, Cambridge University Press, Cambridge, 2007
4. The Physics of Atmospheres, John Houghton, 3rd Edition, Cambridge University Press, Cambridge, 2002.
5. An Introduction to Dynamic Meteorology, J.R. Holton, 4th Edition, Academic Press, London, 2004.
6. A Climate Modelling Primer, K. McGuffie and A. Henderson-Sellers, 3rd Edition, John-wiley, New York, 2004.
7. Advances in Meteorology, Climatology and Atmospheric Physics, D. D. Alexakis, D. G. Hadjimitsis,S. Michaelides, I. Tsanis, A. Retalis, C. Demetriou (auth.), Costas G. Helmis, Panagiotis T. Nastos (eds.), Springer-Verlag Berlin Heidelber, 2013
8. A Perfect Moral Storm: The Ethical Tragedy of Climate Change, Stephen Mark Gardiner, Oxford University Press, 2011
9. A history of the science and politics of climate change: the role of the Intergovernmental Panel on Climate Change, Bert Bolin, Cambridge University Press, 2007.
10. Applied Hydrology by Ven T. Chow, David R. Maidment, and Larry W. Mays,McGraw Hill International Editions.
11. Engineering Hydrology by K. Subramanya, Tata McGraw Hill Publishing Company, New Delhi.
12. Viessman, Jr., Warren; Gary L. Lewis (2003). Introduction to hydrology (5th ed.). Upper Saddle River, N.J.: Pearson Education
13. Hendriks, Martin R. (2010). Introduction to physical hydrology. Oxford: Oxford University Press.
14. Viessman, Jr., Warren; Gary L. Lewis (2003). Introduction to hydrology (5th ed.). Upper Saddle River, N.J.: Pearson Education
15. Rakhecha, Pukhraj, and Vijay P. Singh. Applied hydrometeorology. Springer Science & Business Media, 2009.
16. Collier, C. G. (2016). Hydrometeorology. John Wiley & Sons.
17. Kevin. Sene. (2017). Hydrometeorology: Forecasting and Applications. Springer.
18. Shuttleworth, W. J. (2012). Terrestrial hydrometeorology. John Wiley & Sons.
19. McGuffie, K., & Henderson-Sellers, A. (2014). The climate modelling primer. John Wiley & Sons.
20. Washington, W. M., & Parkinson, C. (2005). Introduction to three-dimensional climate modeling. University science books.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	0	1	2	1	2	3	1	1	2	1	2	1	2	1
CO 2	1	1	2	2	1	2	2	2	1	2	2	2	3	2
CO 3	2	2	2	1	3	2	0	1	2	1	2	1	1	1
CO 4	1	1	1	0	2	1	1	2	2	1	1	1	0	1
CO 5	0	1	2	2	3	2	2	1	1	2	3	2	2	2
CO 6	1	1	2	1	1	3	1	1	2	1	2	1	2	1

GEO524	Hydro- Meteorology Lab II	L	T	P	C
		0	0	3	2
Pre-requisites/Exposure	UG level knowledge of Hydrology and Climatology				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to

CO1. **Apply** hydrological models for surface water resource management.
CO2. **Apply** hydrological models for groundwater resource management.
CO3. **Apply** hydrodynamic models for flood management.
CO4. **Apply** climate models for future climate prediction and drought monitoring

Course Content

Unit I: Hydrological Modelling (15 Hours)
Projects on: Surface and groundwater modelling with Soil & Water Assessment Tool (SWAT), MODFLOW, Artificial Neural Networks (ANN) and Fuzzy logic.

Unit II: Flood Modelling (15 Hours)
Project on: Flood modelling using HEC-RAS, Flood hazard mapping using multi-criteria analysis or fuzzy logic.

Unit III: Climate modelling (15 Hours)
Application of General Circulation Model (GCM) scenario for future climate prediction, Drought monitoring.

Unit IV: Laboratory Notebook and Viva voce

Recommended Readings:
1. Calculating the Weather: Meteorology in the 20th Century, Frederik Nebeker (Eds.), Elsevier, Academic Press, 1995
2. An Introduction to Atmospheric Thermodynamics, A.A. Tsonis, 2nd Edition, Cambridge University Press, Cambridge, 2007
3. Handbook of weather, climate, and water: dynamics, climate, physical meteorology, weather systems, and measurements, Thomas D Potter; Bradley Roy Colman, Wiley-Interscience, 2003.
4. Arnell, N.W., 1996: Global Warming, River Flows and Water Resources. John Wiley and Sons, Chichester, United Kingdom,
5. Braga, B.P.F. and L.C.B. Molion, 1999: Assessment of the impacts of climate variability and change on the hydrology of South America. In: Impacts of Climate Change and Climate Variability on Hydrological Regimes [van Dam, J.C. (ed.)]. UNESCO, International Hydrology Series, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA,
6. D ö l l , P. and S. Siebert, 2001: Global Modeling of Irrigation Wa t e r Requirements. University of Kassel, Kassel, Germany.

7. David K. Pickard, E. M. Tory (auth.), Ian B. MacNeill, Gary J. Umphrey, A. Ian McLeod (eds.): Advances in the Statistical Sciences, 1986: Stochastic Hydrology: Volume IV Festschrift in Honor of Professor V. M. Joshi's 70th Birthday, Springer Netherlands
8. Ven Chow, David Maidment, Larry Mays, 1988: Applied Hydrology, McGraw-Hill Science
9. James J. Sharp and Peter G Sawden (Auth.), 1984: Basic Hydrology, Butterworth-Heinemann
10. BellieSivakumar (auth.), 2017: Chaos in Hydrology: Bridging Determinism and Stochasticity, Springer Netherlands
11. Nicolas G. Adrien, 2003: Computational Hydraulics and Hydrology: An Illustrated Dictionary, CRC Press
12. Gour-Tsyh (George) Yeh (auth.): 1999, Computational Subsurface Hydrology: Fluid Flows, Springer US
13. Rakhecha, P., & Singh, V. P. (2009). Applied hydrometeorology. Springer Science & Business Media.
14. Collier, C. G. (2016). Hydrometeorology. John Wiley & Sons.
15. Sene, K. (2010). Hydrometeorology-Forecasting and Applications. Dordrecht, Springer.
16. Shuttleworth, W. J. (2012). Terrestrial hydrometeorology. John Wiley & Sons.

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO 1	1	1	2	1	1	2	3	1	2	1	2	1	2	1
CO 2	1	1	2	2	2	3	2	2	2	2	2	2	3	2
CO 3	1	0	2	1	3	1	2	1	2	1	2	1	1	1
CO 4	0	1	1	1	2	3	1	2	3	1	2	1	0	1
CO 5	1	1	2	2	2	1	2	1	2	2	0	2	2	0
CO 6	1	1	2	1	2	3	3	1	2	1	2	1	2	1

GEO520	Remote Sensing and GIS II	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	Basic geoinformatics				
Co-requisites	-				

Course Outcomes

On completion of this course, the students will be able to:

CO1. **Integrate** techniques of Geospatial modelling in decision support systems.
CO2. **Appraise** the various dimension of geospatial applications for solving and mitigating real world problems
CO3. **Compile** knowledge about the new concept of Web GIS, Mobile GIS

Course Content

Unit II: Geospatial modelling (20 Hours)
Spatial data modeling and its classification, Concept of Decision Support Systems, Spatial Decision Support Systems, Multi criteria decision support system; Concepts of Agent-based modelling; Spatial Interpolation (deterministic and stochastic models)

Unit II: Application of Remote Sensing and GIS (20 Hours)
Geospatial applications of river basin analysis, water resources management, agriculture, environmental management, hazard and disaster management, resource management; applications of GIS in demography and health geography

Unit III: Geoweb Services and crowd sourcing:(20 Hours)
GIS Data Capture – Crowdsourcing, Volunteered Geographic Information (VGI); Data warehouse and geospatial web services, System architecture for web mapping, elements of web map, OGC, Open source and proprietary web-based scripting and mapping environments, concept of Geo server, Evolution of web mapping, web mapping in recent cartography, societal application of web mapping.

Recommended Readings:
1. Bhatta B., 2011: Remote Sensing and GIS, Oxford Publisher.
2. Campbell J. B., 2007: Introduction to Remote Sensing, Guildford Press.
3. Jensen J. R., 2004: Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall.
4. Joseph, G. 2005: Fundamentals of Remote Sensing, United Press India.
5. Lillesand T. M., Kiefer R. W. and Chipman J. W., 2004: Remote Sensing and Image Interpretation, Wiley. (Wiley Student Edition).
6. Nag P. and Kudra, M., 1998: Digital Remote Sensing, Concept, New Delhi.
7. Rees W. G., 2001: Physical Principles of Remote Sensing, Cambridge University Press.
8. Singh R. B. and Murai S., 1998: Space-informatics for Sustainable Development, Oxford and IBH Pub.
9. Wolf P. R. and Dewitt B. A., 2000: Elements of Photogrammetry: With Applications in GIS, McGrawHill.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	1	1	2	3	2	1	1	1	2	1	2	1	2	1
CO 2	0	1	2	2	2	3	2	2	1	2	2	3	2	2
CO 3	1	2	2	1	2	2	0	1	2	0	2	1	1	1
CO 4	1	1	1	3	2	3	1	2	2	1	1	1	2	1
CO 5	0	1	0	2	2	1	2	1	1	2	2	2	0	2
CO 6	1	1	2	3	2	3	1	1	2	1	2	1	2	1

GEO525	Remote Sensing and GIS Lab II	L	T	P	C
		0	0	3	2
Pre-requisites/Exposure	Remote sensing and GIS theory knowledge				
Co-requisites	Basic GIS knowledge				

Course Outcomes

On completion of this course, the students will be able to:

CO1. **Develop** of multi-criteria decision support systems and spatial analysis in the GIS environment.
CO2. **Apply** geospatial technology for solving and mitigating real world problems.
CO3. **Design** the applications of Web GIS, Mobile GIS etc.

Course Content

Unit II: Geospatial modelling (15 Hours)
GIS modelling: case studies on multi-criteria decision analysis, TIN generation, DEM creation from spot heights, GIS model making for terrain analysis: case studies on terrain and channel morphology analysis

Unit II: Application of Remote Sensing and GIS (15 Hours)
Case studies on flood inundation mapping, land surface temperature (LST) estimation, environmental quality mapping, urban planning; GIS application for infrastructure, resource and utility mapping

Unit III: Geoweb Services and crowd sourcing: (15 Hours)
GIS Data Capture – Crowdsourcing, Volunteered Geographic Information (VGI); Geoserver- a. Evolution of web mapping, web mapping in recent cartography, societal application of web mapping, b. System architecture for web mapping, elements of web map, setting up Geo server, analyses two web maps

Unit IV: Laboratory Notebook and Viva voce

Recommended Readings:

1. Bhatta B., 2011: Remote Sensing and GIS, Oxford Publisher.
2. Campbell J. B., 2007: Introduction to Remote Sensing, Guildford Press.
3. Jensen J. R., 2004: Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall.
4. Joseph, G. 2005: Fundamentals of Remote Sensing, United Press India.
5. Lillesand T. M., Kiefer R. W. and Chipman J. W., 2004: Remote Sensing and Image Interpretation, Wiley. (Wiley Student Edition).
6. Nag P. and Kudra, M., 1998: Digital Remote Sensing, Concept, New Delhi.
7. Rees W. G., 2001: Physical Principles of Remote Sensing, Cambridge University Press.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	1	1	2	1	2	2	3	1	2	1	2	1	2	1
CO 2	0	0	2	2	2	2	2	2	2	2	2	2	2	2
CO 3	1	2	2	1	2	3	2	1	2	1	3	1	1	1
CO 4	1	1	1	1	2	2	2	2	2	1	0	1	2	1
CO 5	1	1	0	2	2	3	2	1	2	2	2	2	2	2
CO 6	1	1	2	1	2	2	3	1	2	1	2	1	2	0

GEO527	Dissertation II	L	T	P	C
					6
Pre-requisites/Exposure	In depth knowledge on masters level special paper, and research methodology				
Co-requisites	Statistics and GIS software knowledge and writing skill				

Course Outcomes

On completion of this course, the students will be able to:

CO1. **Analyze** data to solve research problems for specified research objectives
CO2. **Design** research report writing and scientific articles for publication.
CO3. **Construct** own research design for life-long learning.
CO4. **Appraise** ethical aspects of research and development work for professional development.
CO5. **Develop** writing and communication skills.

Course Content

Dissertation (90 Hours)

Dissertation Paper comprises an Object–specific goal–oriented Geographical Study based on the following types: 1) those which test a hypothesis or theory, as virtually all aspects of Geography have theories attached to them, 2) those which compare the geographical characteristics of two places or phenomena. A variation on this theme is a comparison of the geographical characteristics of one place or phenomena at two or more stages of time, i.e., a study of changes over time, and 3) those which study a geographical problem related to the habitat, economy and society of people.

1) Each Examinee shall prepare a Dissertation Paper individually under the supervision of a Departmental Faculty on his / her own chosen Theme.
2) The Report must be documented in triplicate (1 = examinee, 2 = seminar library, 3 = supervisor) under the following Heads – *Introduction & Conceptual Background; Statement of the Problem; Objectives of Study; Literature Review; Methodology including data / information / map collection; Location of the Study Area; Analysis, Display and Interpretation of Data (relating to each Objective separately); and Conclusion.*
3) The Dissertation Paper should contain *Acknowledgement, Preface, Table of Content, List of Tables,*
4) *List of Figures, List of Photographs, List of References, Appendix, and Bibliography/ Reference.*
5) Pages containing Illustrations (Sketches, Graphs, Diagrams, Maps, Photographs, etc.) = 25 (maximum).
6) Word Limit = 8000 (maximum) excluding Tables and Appendix (Computer typed, Line Spacing = 1½, Arial Narrow / Times New Roman / Helvetica 10 / 11 / 12).
7) Each Examinee shall submit a copy of the Report before the actual day of Examination (to be announced by the convener each year).
8) Each Examinee shall present his / her Paper before an audience comprising Internal / External
9) Examiners and others on the day of Examination using OHP or LCD Projector (maximum 25 slides about ―*concept / idea / theme; major objectives; methodology; study area; observations and analysis; conclusion*).
10) Time allotted for each presentation = 20 minutes (maximum).
11) Marks on Report and Presentation shall be separately awarded by the Internal and External
12) Examiners and then averaged.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	1	1	2	1	2	2	3	1	2	1	2	1	2	1
CO 2	0	0	2	2	2	2	2	2	2	2	2	2	2	2
CO 3	1	2	2	1	2	3	2	1	2	1	3	1	1	1
CO 4	1	1	1	1	2	2	2	2	2	1	0	1	2	1
CO 5	1	1	0	2	2	3	2	1	2	2	2	2	2	2
CO 6	1	1	2	1	2	2	3	1	2	1	2	1	2	0

GEO528	Field Project	L	T	P	C
		0	0	4	4
Pre-requisites/Exposure	Graduate level exposure to field excursion				
Co-requisites	Statistics and GIS knowledge and report writing skill				

Course Outcomes

On completion of this course, the students will be able to:

CO1. **Conclude** inference on socio-economic status and problems by statistical analysis of data.

CO2. **Interpret** physical and social conditions through preparing maps and diagrams using geospatial technology.

CO3. **Represent** social and environmental problems and their solutions through scientific report and presentation.

Course Content

Field Report and Viva (60 Hours)

A Field Report to be prepared and submitted individually by each student, based on actual Field Survey of an area, done jointly or in groups with other students under the supervision of a Prof–in–Charge, Field Study. A Field Survey shall involve "Identification, Mapping and Interpretation of Salient Features of the Habitat, Economy and Society of the Local Inhabitants".

- Measurement and mapping of slope using Clinometer / Dumpy Level / Abney Level etc
- Measurement and mapping of geomorphic and geographical features with GPS and other relevant instruments
- Acquisition and mapping of landuse pattern by 'plot–to–plot' survey using cadastral map
- Acquisition and mapping of socio-economic data by 'door–to–door' household enumeration using questionnaire
- Identifying the relations between and among the attributes / components of: habitat, economy and society
- Pages containing illustrations (sketches, graphs, diagrams, maps, photographs, etc) = 20 (maximum)
- Documentation and generation of the field report with the following arrangement: preface, introduction, objectives, methodology, data acquisition, data analysis, data display and interpretation, analysis and conclusion, appendices (of data), and bibliography / references
- Word Limit = 8000 (maximum) excluding Tables and Appendix (Computer typed, Line Spacing = 1½, Arial Narrow / Times New Roman / Helvetica 10 / 11/ 12)
- Time allotted for Viva Voce / Examinee = 15 minutes (maximum)
- Marks on Report shall be awarded by the Internal Examiners and on Viva Voce by the External
- Examiners and then added together.

Recommended Readings:

2. Basu, R. and Bhaduri, S. ed, (2007): Contemporary Issues and Techniques in Geography, Progressive Publishers, Kolkata.
3. Mukherjee, N. (2002): Participatory Learning and Action: with 100 Field Methods. Concept Publs. Co., New Delhi.
4. Robinson, A. (1998): "Thinking Straight and Writing That Way", in Writing Empirical Research Reports:A Basic Guide for Students of the Social and Behavioural Sciences, eds. by F. Pryczak and R. Bruce Pryczak, Publishing: Los Angeles.
5. Special Issue on "Doing Fieldwork" The Geographical Review 91:1-2 (2001).

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	0	1	2	1	2	3	1	1	2	1	2	1	2	1
CO 2	1	1	2	2	1	2	2	2	1	2	2	2	3	2
CO 3	2	2	2	1	3	2	0	1	2	1	2	1	1	1
CO 4	1	1	1	0	2	1	1	2	2	1	1	1	0	1
CO 5	0	1	2	2	3	2	2	1	1	2	3	2	2	2
CO 6	1	1	2	1	1	3	1	1	2	1	2	1	2	1

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4
GEO451	**2.67**	**2.67**	**2.67**	**2.00**	**2.00**	**2.83**	**2.17**	**1.67**	**2.17**	**2.83**	**2.67**	**2.67**	**2.67**	**2.83**
CO 1	3	2	2	1	1	2	1	1	1	3	2	2	2	3
CO 2	3	3	2	2	1	3	2	1	2	3	3	3	3	2
CO 3	3	3	3	2	2	3	2	1	2	2	2	2	2	3
CO 4	2	3	3	2	2	3	3	2	2	3	3	3	3	3
CO 5	2	2	3	2	3	3	2	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO452	**2.83**	**2.83**	**2.83**	**2.67**	**2.00**	**2.50**	**2.33**	**1.67**	**2.50**	**3.00**	**3.00**	**2.83**	**3.00**	**2.83**
CO 1	3	3	2	2	1	2	2	1	2	3	3	3	3	2
CO 2	3	3	3	2	1	2	2	1	2	3	3	2	3	3
CO 3	3	3	3	3	2	2	2	1	2	3	3	3	3	3
CO 4	2	2	3	3	2	3	3	2	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO453	**3.00**	**3.00**	**3.00**	**3.00**	**2.83**	**3.00**	**2.83**	**2.50**	**2.83**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
CO 1	3	3	3	3	2	3	2	1	2	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO454	**3.00**	**3.00**	**2.83**	**2.83**	**3.00**	**3.00**	**2.83**	**2.17**	**2.83**	**3.00**	**3.00**	**3.00**	**3.00**	**2.83**
CO 1	3	3	2	2	3	3	2	1	2	3	3	3	3	2

CO 2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO455	**2.83**	**2.67**	**2.83**	**2.67**	**2.00**	**2.67**	**2.17**	**1.67**	**2.50**	**3.00**	**2.83**	**2.67**	**3.00**	**2.83**
CO 1	3	2	2	2	1	2	1	1	2	3	2	2	3	2
CO 2	3	3	3	2	1	2	2	1	2	3	3	2	3	3
CO 3	3	3	3	3	2	3	2	1	2	3	3	3	3	3
CO 4	2	2	3	3	2	3	3	2	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO456	**3.00**	**3.00**	**2.83**	**2.83**	**2.83**	**3.00**	**2.83**	**2.33**	**2.83**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
CO 1	3	3	2	2	3	3	2	2	2	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 3	3	3	3	3	2	3	3	2	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO457	**3.00**	**3.00**	**2.83**	**3.00**	**2.67**	**2.83**	**2.67**	**2.50**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
CO 1	3	3	2	3	2	2	2	2	3	3	3	3	3	3
CO 2	3	3	3	3	2	3	2	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO458	**3.00**	**3.00**	**3.00**	**3.00**	**2.83**	**3.00**	**2.83**	**2.50**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
CO 1	3	3	3	3	2	3	2	1	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO459	**2.83**	**2.67**	**2.83**	**2.67**	**1.83**	**2.67**	**2.33**	**1.50**	**2.50**	**3.00**	**3.00**	**2.83**	**3.00**	**2.83**
CO 1	3	3	2	2	1	2	2	1	2	3	3	3	3	3
CO 2	3	3	3	2	1	2	2	1	2	3	3	2	3	2
CO 3	3	2	3	3	1	3	2	1	2	3	3	3	3	3
CO 4	2	2	3	3	2	3	3	1	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO460	**0.83**	**1.17**	**1.83**	**1.17**	**2.00**	**2.17**	**1.17**	**1.33**	**1.67**	**1.33**	**2.00**	**1.33**	**1.67**	**1.33**
CO 1	0	1	2	1	2	3	1	1	2	1	2	1	2	1
CO 2	1	1	2	2	1	2	2	2	1	2	2	2	3	2
CO 3	2	2	2	1	3	2	0	1	2	1	2	1	1	1
CO 4	1	1	1	0	2	1	1	2	2	1	1	1	0	1
CO 5	0	1	2	2	3	2	2	1	1	2	3	2	2	2
CO 6	1	1	2	1	1	3	1	1	2	1	2	1	2	1
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO461	**3.00**	**3.00**	**2.83**	**3.00**	**2.00**	**2.67**	**2.33**	**2.33**	**2.83**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
CO 1	3	3	2	3	1	2	1	1	2	3	3	3	3	3

CO 2	3	3	3	3	2	2	2	2	3	3	3	3	3	3
CO 3	3	3	3	3	2	3	2	2	3	3	3	3	3	3
CO 4	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO462	**3.00**	**2.83**	**2.67**	**2.83**	**2.00**	**2.67**	**2.17**	**1.83**	**2.67**	**3.00**	**2.83**	**2.83**	**3.00**	**3.00**
CO 1	3	3	2	2	1	2	1	1	2	3	2	2	3	3
CO 2	3	3	3	3	2	3	2	2	3	3	3	3	3	3
CO 3	3	2	2	3	1	2	2	1	2	3	3	3	3	3
CO 4	3	3	3	3	2	3	3	2	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO463	**3.00**	**3.00**	**2.83**	**2.83**	**2.33**	**2.83**	**2.67**	**2.00**	**3.00**	**3.00**	**2.83**	**2.83**	**3.00**	**2.83**
CO 1	3	3	2	2	1	2	2	1	3	3	2	2	3	2
CO 2	3	3	3	3	2	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	2	1	3	3	3	3	3	3
CO 4	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO464	**3.00**	**2.83**	**2.83**	**2.50**	**1.83**	**2.67**	**2.33**	**1.67**	**2.50**	**3.00**	**2.83**	**2.83**	**3.00**	**2.83**
CO 1	3	2	2	2	1	2	2	1	2	3	2	2	3	2
CO 2	3	3	3	2	1	2	2	1	2	3	3	3	3	3
CO 3	3	3	3	2	1	3	2	1	2	3	3	3	3	3
CO 4	3	3	3	3	2	3	3	2	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	2	2	3	3	3	3	3	3

CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO465	**3.00**	**3.00**	**3.00**	**3.00**	**2.83**	**3.00**	**2.83**	**2.50**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
CO 1	3	3	3	3	2	3	2	1	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO500	**2.83**	**2.83**	**3.00**	**2.83**	**2.33**	**2.83**	**2.50**	**1.83**	**2.67**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
CO 1	3	3	3	2	1	2	2	1	2	3	3	3	3	3
CO 2	3	2	3	3	2	3	2	2	2	3	3	3	3	3
CO 3	3	3	3	3	2	3	3	1	3	3	3	3	3	3
CO 4	2	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO501	**3.00**	**3.00**	**3.00**	**3.00**	**2.83**	**3.00**	**2.83**	**2.67**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
CO 1	3	3	3	3	2	3	2	2	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO502	**3.00**	**3.00**	**3.00**	**3.00**	**2.83**	**3.00**	**2.83**	**2.67**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
CO 1	3	3	3	3	2	3	2	2	3	3	3	3	3	3

CO 2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO503	**3.00**	**3.00**	**3.00**	**2.83**	**2.67**	**3.00**	**2.83**	**2.33**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
CO 1	3	3	3	2	2	3	2	1	3	3	3	3	3	3
CO 2	3	3	3	3	2	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO508	**0.83**	**0.83**	**1.83**	**1.33**	**2.00**	**2.17**	**2.17**	**1.33**	**2.17**	**1.33**	**1.67**	**1.33**	**1.67**	**1.00**
CO 1	1	1	2	1	1	2	3	1	2	1	2	1	2	1
CO 2	1	1	2	2	2	3	2	2	2	2	2	2	3	2
CO 3	1	0	2	1	3	1	2	1	2	1	2	1	1	1
CO 4	0	1	1	1	2	3	1	2	3	1	2	1	0	1
CO 5	1	1	2	2	2	1	2	1	2	2	0	2	2	0
CO 6	1	1	2	1	2	3	3	1	2	1	2	1	2	1
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO504	**3.00**	**3.00**	**3.00**	**3.00**	**2.83**	**3.00**	**2.83**	**2.50**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
CO 1	3	3	3	3	2	3	2	1	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO509	**3.00**	**3.00**	**3.00**	**3.00**	**2.83**	**3.00**	**2.83**	**2.50**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
CO 1	3	3	3	3	2	3	2	1	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO505	**3.00**	**3.00**	**3.00**	**3.00**	**2.83**	**3.00**	**2.83**	**2.50**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
CO 1	3	3	3	3	2	3	2	1	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO510	**0.83**	**1.17**	**1.83**	**1.17**	**2.00**	**2.17**	**1.17**	**1.33**	**1.67**	**1.33**	**2.00**	**1.33**	**1.67**	**1.33**
CO 1	0	1	2	1	2	3	1	1	2	1	2	1	2	1
CO 2	1	1	2	2	1	2	2	2	1	2	2	2	3	2
CO 3	2	2	2	1	3	2	0	1	2	1	2	1	1	1
CO 4	1	1	1	0	2	1	1	2	2	1	1	1	0	1
CO 5	0	1	2	2	3	2	2	1	1	2	3	2	2	2
CO 6	1	1	2	1	1	3	1	1	2	1	2	1	2	1
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO506	**0.83**	**0.83**	**1.83**	**1.33**	**2.00**	**2.17**	**2.17**	**1.33**	**2.17**	**1.33**	**1.67**	**1.33**	**1.67**	**1.00**
CO 1	1	1	2	1	1	2	3	1	2	1	2	1	2	1

CO 2	1	1	2	2	2	3	2	2	2	2	2	2	3	2
CO 3	1	0	2	1	3	1	2	1	2	1	2	1	1	1
CO 4	0	1	1	1	2	3	1	2	3	1	2	1	0	1
CO 5	1	1	2	2	2	1	2	1	2	2	0	2	2	0
CO 6	1	1	2	1	2	3	3	1	2	1	2	1	2	1
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO511	**0.67**	**1.17**	**1.50**	**2.33**	**2.00**	**2.17**	**1.17**	**1.33**	**1.67**	**1.17**	**1.83**	**1.50**	**1.50**	**1.33**
CO 1	1	1	2	3	2	1	1	1	2	1	2	1	2	1
CO 2	0	1	2	2	2	3	2	2	1	2	2	3	2	2
CO 3	1	2	2	1	2	2	0	1	2	0	2	1	1	1
CO 4	1	1	1	3	2	3	1	2	2	1	1	1	2	1
CO 5	0	1	0	2	2	1	2	1	1	2	2	2	0	2
CO 6	1	1	2	3	2	3	1	1	2	1	2	1	2	1
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO507	**0.83**	**1.00**	**1.50**	**1.33**	**2.00**	**2.33**	**2.33**	**1.33**	**2.00**	**1.33**	**1.83**	**1.33**	**1.83**	**1.17**
CO 1	1	1	2	1	2	2	3	1	2	1	2	1	2	1
CO 2	0	0	2	2	2	2	2	2	2	2	2	2	2	2
CO 3	1	2	2	1	2	3	2	1	2	1	3	1	1	1
CO 4	1	1	1	1	2	2	2	2	2	1	0	1	2	1
CO 5	1	1	0	2	2	3	2	1	2	2	2	2	2	2
CO 6	1	1	2	1	2	2	3	1	2	1	2	1	2	0
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO512	**0.83**	**1.00**	**1.83**	**2.00**	**2.00**	**2.17**	**1.33**	**1.33**	**1.67**	**1.33**	**1.83**	**1.17**	**1.83**	**1.00**
CO 1	1	1	2	2	2	2	1	1	2	1	2	1	2	1
CO 2	1	0	2	2	2	2	2	2	1	2	2	2	2	2
CO 3	1	2	2	2	2	2	1	1	2	1	2	1	1	1
CO 4	1	1	1	3	2	3	1	2	2	1	1	0	2	1
CO 5	0	1	2	2	2	1	2	1	1	2	2	2	2	0

CO 6	1	1	2	1	2	3	1	1	2	1	2	1	2	1
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO513	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**2.83**	**2.67**	**2.67**	**2.83**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
CO 1	3	3	3	3	3	2	2	3	2	3	3	3	3	3
CO 2	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO514	**3.00**	**3.00**	**3.00**	**3.00**	**2.67**	**2.67**	**2.50**	**2.67**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
CO 1	3	3	3	3	2	2	2	2	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO 3	3	3	3	3	2	2	2	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO515	**0.83**	**0.83**	**1.83**	**1.33**	**2.00**	**2.17**	**2.17**	**1.33**	**2.17**	**1.33**	**1.67**	**1.33**	**1.67**	**1.00**
CO 1	1	1	2	1	1	2	3	1	2	1	2	1	2	1
CO 2	1	1	2	2	2	3	2	2	2	2	2	2	3	2
CO 3	1	0	2	1	3	1	2	1	2	1	2	1	1	1
CO 4	0	1	1	1	2	3	1	2	3	1	2	1	0	1
CO 5	1	1	2	2	2	1	2	1	2	2	0	2	2	0
CO 6	1	1	2	1	2	3	3	1	2	1	2	1	2	1
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO516	**0.67**	**1.17**	**1.50**	**2.33**	**2.00**	**2.17**	**1.17**	**1.33**	**1.67**	**1.17**	**1.83**	**1.50**	**1.50**	**1.33**
CO 1	1	1	2	3	2	1	1	1	2	1	2	1	2	1

CO 2	0	1	2	2	2	3	2	2	1	2	2	3	2	2
CO 3	1	2	2	1	2	2	0	1	2	0	2	1	1	1
CO 4	1	1	1	3	2	3	1	2	2	1	1	1	2	1
CO 5	0	1	0	2	2	1	2	1	1	2	2	2	0	2
CO 6	1	1	2	3	2	3	1	1	2	1	2	1	2	1
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO521	**0.83**	**1.00**	**1.50**	**1.33**	**2.00**	**2.33**	**2.33**	**1.33**	**2.00**	**1.33**	**1.83**	**1.33**	**1.83**	**1.17**
CO 1	1	1	2	1	2	2	3	1	2	1	2	1	2	1
CO 2	0	0	2	2	2	2	2	2	2	2	2	2	2	2
CO 3	1	2	2	1	2	3	2	1	2	1	3	1	1	1
CO 4	1	1	1	1	2	2	2	2	2	1	0	1	2	1
CO 5	1	1	0	2	2	3	2	1	2	2	2	2	2	2
CO 6	1	1	2	1	2	2	3	1	2	1	2	1	2	0
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO517	**0.83**	**1.17**	**1.83**	**1.17**	**2.00**	**2.17**	**1.17**	**1.33**	**1.67**	**1.33**	**2.00**	**1.33**	**1.67**	**1.33**
CO 1	0	1	2	1	2	3	1	1	2	1	2	1	2	1
CO 2	1	1	2	2	1	2	2	2	1	2	2	2	3	2
CO 3	2	2	2	1	3	2	0	1	2	1	2	1	1	1
CO 4	1	1	1	0	2	1	1	2	2	1	1	1	0	1
CO 5	0	1	2	2	3	2	2	1	1	2	3	2	2	2
CO 6	1	1	2	1	1	3	1	1	2	1	2	1	2	1
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO522	**0.83**	**0.83**	**1.83**	**1.33**	**2.00**	**2.17**	**2.17**	**1.33**	**2.17**	**1.33**	**1.67**	**1.33**	**1.67**	**1.00**
CO 1	1	1	2	1	1	2	3	1	2	1	2	1	2	1
CO 2	1	1	2	2	2	3	2	2	2	2	2	2	3	2
CO 3	1	0	2	1	3	1	2	1	2	1	2	1	1	1
CO 4	0	1	1	1	2	3	1	2	3	1	2	1	0	1
CO 5	1	1	2	2	2	1	2	1	2	2	0	2	2	0

CO 6	1	1	2	1	2	3	3	1	2	1	2	1	2	1
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO518	**0.67**	**1.17**	**1.50**	**2.33**	**2.00**	**2.17**	**1.17**	**1.33**	**1.67**	**1.17**	**1.83**	**1.50**	**1.50**	**1.33**
CO 1	1	1	2	3	2	1	1	1	2	1	2	1	2	1
CO 2	0	1	2	2	2	3	2	2	1	2	2	3	2	2
CO 3	1	2	2	1	2	2	0	1	2	0	2	1	1	1
CO 4	1	1	1	3	2	3	1	2	2	1	1	1	2	1
CO 5	0	1	0	2	2	1	2	1	1	2	2	2	0	2
CO 6	1	1	2	3	2	3	1	1	2	1	2	1	2	1
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO523	**0.83**	**1.00**	**1.50**	**1.33**	**2.00**	**2.33**	**2.33**	**1.33**	**2.00**	**1.33**	**1.83**	**1.33**	**1.83**	**1.17**
CO 1	1	1	2	1	2	2	3	1	2	1	2	1	2	1
CO 2	0	0	2	2	2	2	2	2	2	2	2	2	2	2
CO 3	1	2	2	1	2	3	2	1	2	1	3	1	1	1
CO 4	1	1	1	1	2	2	2	2	2	1	0	1	2	1
CO 5	1	1	0	2	2	3	2	1	2	2	2	2	2	2
CO 6	1	1	2	1	2	2	3	1	2	1	2	1	2	0
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO519	**0.83**	**1.17**	**1.83**	**1.17**	**2.00**	**2.17**	**1.17**	**1.33**	**1.67**	**1.33**	**2.00**	**1.33**	**1.67**	**1.33**
CO 1	0	1	2	1	2	3	1	1	2	1	2	1	2	1
CO 2	1	1	2	2	1	2	2	2	1	2	2	2	3	2
CO 3	2	2	2	1	3	2	0	1	2	1	2	1	1	1
CO 4	1	1	1	0	2	1	1	2	2	1	1	1	0	1
CO 5	0	1	2	2	3	2	2	1	1	2	3	2	2	2
CO 6	1	1	2	1	1	3	1	1	2	1	2	1	2	1
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO524	**0.83**	**0.83**	**1.83**	**1.33**	**2.00**	**2.17**	**2.17**	**1.33**	**2.17**	**1.33**	**1.67**	**1.33**	**1.67**	**1.00**
CO 1	1	1	2	1	1	2	3	1	2	1	2	1	2	1

CO 2	1	1	2	2	2	3	2	2	2	2	2	2	3	2
CO 3	1	0	2	1	3	1	2	1	2	1	2	1	1	1
CO 4	0	1	1	1	2	3	1	2	3	1	2	1	0	1
CO 5	1	1	2	2	2	1	2	1	2	2	0	2	2	0
CO 6	1	1	2	1	2	3	3	1	2	1	2	1	2	1
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO520	**0.67**	**1.17**	**1.50**	**2.33**	**2.00**	**2.17**	**1.17**	**1.33**	**1.67**	**1.17**	**1.83**	**1.50**	**1.50**	**1.33**
CO 1	1	1	2	3	2	1	1	1	2	1	2	1	2	1
CO 2	0	1	2	2	2	3	2	2	1	2	2	3	2	2
CO 3	1	2	2	1	2	2	0	1	2	0	2	1	1	1
CO 4	1	1	1	3	2	3	1	2	2	1	1	1	2	1
CO 5	0	1	0	2	2	1	2	1	1	2	2	2	0	2
CO 6	1	1	2	3	2	3	1	1	2	1	2	1	2	1
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO525	**0.83**	**1.00**	**1.50**	**1.33**	**2.00**	**2.33**	**2.33**	**1.33**	**2.00**	**1.33**	**1.83**	**1.33**	**1.83**	**1.17**
CO 1	1	1	2	1	2	2	3	1	2	1	2	1	2	1
CO 2	0	0	2	2	2	2	2	2	2	2	2	2	2	2
CO 3	1	2	2	1	2	3	2	1	2	1	3	1	1	1
CO 4	1	1	1	1	2	2	2	2	2	1	0	1	2	1
CO 5	1	1	0	2	2	3	2	1	2	2	2	2	2	2
CO 6	1	1	2	1	2	2	3	1	2	1	2	1	2	0
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO527	**0.83**	**1.00**	**1.50**	**1.33**	**2.00**	**2.33**	**2.33**	**1.33**	**2.00**	**1.33**	**1.83**	**1.33**	**1.83**	**1.17**
CO 1	1	1	2	1	2	2	3	1	2	1	2	1	2	1
CO 2	0	0	2	2	2	2	2	2	2	2	2	2	2	2
CO 3	1	2	2	1	2	3	2	1	2	1	3	1	1	1
CO 4	1	1	1	1	2	2	2	2	2	1	0	1	2	1
CO 5	1	1	0	2	2	3	2	1	2	2	2	2	2	2

CO 6	1	1	2	1	2	2	3	1	2	1	2	1	2	0
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
GEO528	**0.83**	**1.17**	**1.83**	**1.17**	**2.00**	**2.17**	**1.17**	**1.33**	**1.67**	**1.33**	**2.00**	**1.33**	**1.67**	**1.33**
CO 1	0	1	2	1	2	3	1	1	2	1	2	1	2	1
CO 2	1	1	2	2	1	2	2	2	1	2	2	2	3	2
CO 3	2	2	2	1	3	2	0	1	2	1	2	1	1	1
CO 4	1	1	1	0	2	1	1	2	2	1	1	1	0	1
CO 5	0	1	2	2	3	2	2	1	1	2	3	2	2	2
CO 6	1	1	2	1	1	3	1	1	2	1	2	1	2	1