Four Year Undergraduate Program (FYUGP) in Geospatial Technology

Under

New Education Policy-2020

Department of Planning & Geomatics
Islamic University of Science and Technology

Four Year Undergraduate Program (FYUGP) in Geospatial Technology at Department of Planning & Geomatics

1. Introduction:

The field of Geospatial Technology is rapidly expanding with significant global growth and applications in various industries. Recognizing the demand for skilled professionals in geospatial analysis and technology, we propose to establish a comprehensive four-year undergraduate program in Geospatial Technology. The program aims to produce graduates with strong theoretical foundations and practical skills necessary to excel in the industry and academia. This initiative aligns with the principles of NEP 2020, emphasizing a multidisciplinary and holistic approach.

The Program will be offered in association with the other allied Departments/Centres and will be in line with NEP-2020. The program will be a credit-based offering flexibility in the course curriculum. The BS program in Geospatial Technology will be of four-year duration, comprising eight semesters with Major in Geomatics and Minors in Mathematical Sciences and Computer Sciences. Students admitted to this program, like any other four-year Bachelor's programme will have the option to earn a Master's degree in "Geomatics, Remote Sensing, Geoinformatics and Geospatial sciences" by spending one more year over and above the Bachelor's program (normal duration to earn dual degree is 4+1=5 years). The students admitted to four-year Bachelor's program under Design your degree offered by the University will have an option to earn a major in "Geospatial Technology", for that limited number of seats will be earmarked.

2. Rationale:

Geospatial Technology encompasses the technologies and methods for collecting, analysing, and interpreting geographic information. With the advent of digital mapping and location-based services, the significance of geospatial data has grown exponentially, influencing a wide range of sectors. This program is designed to meet the increasing demand for skilled professionals in geospatial analysis, remote sensing, and Geographic Information Systems (GIS). Here are some key reasons why this program is essential:

1. **Industry Demand**: Growing reliance on geospatial data across sectors such as urban planning, agriculture, environmental management, and transportation has created a demand for professionals skilled in geospatial technologies. This program aims to prepare graduates for roles such as GIS analysts, remote sensing specialists, cartographers, geospatial data scientists, urban planners, and

environmental consultants. Industries ranging from government agencies, environmental firms, and urban development authorities to private technology companies are actively seeking expertise in these areas.

2. **Technological Advancements**: Revolutionary advancements in satellite imagery, drones, and big data analytics have transformed how geographic data is captured and analysed.
3. **Multidisciplinary Applications**: Geospatial Technology has applications across disciplines, including environmental science, civil engineering, and public health, enabling students to work in diverse fields, enhancing their versatility and employability.
4. **Contribution to Society:** Geospatial technologies play a crucial role in addressing societal challenges such as climate change, disaster management, and sustainable development. By training students in these technologies, the program will contribute to building a workforce capable of developing solutions to these pressing issues.
5. **Research Opportunities:** The field of Geospatial Technology offers numerous opportunities for research and innovation. The program will encourage students to engage in research projects, fostering a culture of inquiry and discovery that can lead to new insights and advancements in the field.
6. **Alignment with NEP 2020:** The program aligns with the National Education Policy 2020, which emphasizes the importance of a holistic and multidisciplinary education. By integrating geospatial sciences with other disciplines, the program will provide students with a well-rounded education that prepares them for the challenges of the 21st century.

By establishing this undergraduate program, we aim to produce graduates who are well-equipped to meet the challenges of the geospatial industry and contribute meaningfully to society through innovative solutions.

3. Program Educational Objectives (PEOs)

PEO 1: Graduates will excel in professional skills, fundamental knowledge, and advanced technologies to become leaders in Geospatial Technology.

PEO 2: Graduates will solve complex real-world problems using geospatial technologies and methodologies.

PEO 3: Graduates will engage in lifelong learning with social and ethical awareness in their profession.

4. Programme Outcomes (POs)

Upon successful completion of the BS in Geospatial Technology, graduates will:

PO 1: Apply analytical and critical thinking to solve complex geospatial problems.

PO 2: Possess entrepreneurial skills to innovate and create value in the geospatial industry.

PO 3: Demonstrate proficiency in modern geospatial technologies and methodologies.

PO 4: Develop and implement geospatial analysis strategies with ethical considerations.

PO 5: Engage in self-directed learning in the evolving field of geospatial sciences.

PO 6: Conduct independent research contributing to advancements in the field.

5. Programme Specific Outcomes (PSOs)

After completing the program, students are expected to:

PSO 1: Design and implement geospatial solutions to real-world problems.

PSO 2: Apply geospatial tools and techniques across multidisciplinary fields.

PSO 3: Evaluate the role of geospatial analytics in career and research activities.

6. Programme Details:

In alignment with the transformative vision laid out in the National Education Policy (NEP) of 2020, the Department of Planning & Geomatics at the Islamic University of Science and Technology (IUST), Kashmir, takes pride in inaugurating its Bachelor of Science (BS) program in Geospatial Technology. This comprehensive BS program has been meticulously designed to offer a multidisciplinary curriculum, drawing from the fields Statistics, Computer Science, Artificial Intelligence, and domain-specific knowledge. Through a judicious blend of theoretical foundations, practical applications, and hands-on experience, students will develop a nuanced understanding of GIS and Remote Sensing principles, methodologies, and tools, preparing them to navigate the complexities of real-world Phenomenon, interpretation and modelling.

The program will be credit-based offering flexibility in the course curriculum and will include combination of major, minor, skill-based courses, value-added courses, vocational courses, Multidisciplinary courses, Internship and project work. The program offers a multidisciplinary curriculum drawing from Geography, Computer Science, and Remote Sensing. It includes a blend of theoretical foundations, practical applications, and hands-on experience.

Structure:

Duration: Four years, eight semesters.

Major: Geomatics and Geospatial Sciences.

Minor: Data Sciences, Artificial Intelligence. Environmental Sciences

Multiple Entry Exit System (MEES):

After one year: Certificate

After two years: Diploma

After three years: Bachelor's degree

After four years: BS Honors or BS Research degree

7. **Intake Capacity, Fee and Eligibility Criteria**

   Intake Capacity: 32 Students (24-OM & Reserved categories+06-Self-finance+02-NRI Sponsored)

   Fee per Semester: INR 19,200/- (OM & Reserved), 50,000/- (Self-finance), 1,00,000/- (NRI)

   Eligibility Criteria: Any candidate having passed 10+2 with a minimum of 45% marks from the J&K Board of School Education or from any other recognized board with any of the Science subject as one of the Compulsory subjects.

8. **Faculty and Infrastructure Requirements:**

   The B.Sc. program in Geospatial Technology, although primarily housed within the Department of Planning & Geomatics, will feature a multidisciplinary approach in its curriculum delivery. To enrich the learning experience and ensure a comprehensive educational offering, resources and expertise from various allied departments/centres will be actively integrated. These departments/ Centres, including Computer Science and Engineering (ECE), Computer Science (CS), Centre for Artificial Intelligence, English Language and Literature, Design Innovation Centre, Centre for Disaster Risk Reduction and Department of Environment, Sustainability and Climate Change. Faculty members from these departments, known for their specialized knowledge and experience in their respective fields, will play a crucial role in teaching courses within the BS program in Geomatics. This strategy will help in optimum utilization of interdisciplinary resources available in the University. Initially, existing resources will be utilized, with plans for future expansion, including dedicated GIS lab, classrooms, software licenses, and specialized faculty.

9. **Course Structure**

Annexure-I

Year-1: Foundation in Geospatial sciences & interdisciplinary exposure

1ST SEMESTER

Course Code	Course Title	Category	Hours/Week				Credits
			L	T	P	S	
DPG100MJ	Introduction to Space Technology & Earth Observation	Major	2	1	1	-	4
Minor-1	Course offered by allied Departments	Minor[1]					4
DOMS100MD	Statistical Methods	Multidisciplinary[2]					3
DOELL100AE	Technical Writing	Ability Enhancement[3]					3
DJMC100SE	Multimedia Editing	Skill Enhancement[4]					2
VAC-1	Digital & Technological Solutions	Value added[5]					2
CVS100VA	Health & wellness						2
	Total Credits: 20						

2nd SEMESTER

Course Code	Course Title	Category	Hours/Week				Credits
			L	T	P	S	
DPG150MJ	Fundamentals of Geospatial Technologies	Major	2	1	1	-	4
Minor-2	Course offered by allied Departments	Minor					4
CDRR100MD	Understanding Natural Disasters	Multidisciplinary					3
DOELL100AE	Communication Skills	Ability Enhancement					3
DOMS201SE	Python Programming	Skill Enhancement					2
CIR150VA	Understanding India	Value added					2
DOMS150VA	Environmental Science						2
	Total Credits: 20						

Year-2: Specialised Geospatial knowledge

3rd SEMESTER

Course Code	Course Title	Category	Hours/Week				Credits
			L	T	P	S	
DPG200MJ	ICT & Programming for Geoinformation Management	Major	2	1	1	-	4
DPG201MJ	Geospatial Data Bases	Major	2	1	1	-	4
Minor-3	Course offered by allied Departments	Minor					4
CAI101MD	Generative AI/ Managing Disasters	Multidisciplinary					3
DELL201AE	Kashmiri/Urdu Language	Ability Enhancement					2
DOMS200SE	R Software	Skill Enhancement					3
	Total Credits: 20						

4th SEMESTER

Course Code	Course Title	Category	Hours/Week				Credits
			L	T	P	S	
DPG250MJ	Remote Sensing Techniques & Applications	Major	2	1	1	0	4
DPG251MJ	Spatial Analysis	Major	2	1	1	-	4
DPG252MJ	Digital Cartography	Major	2	1	1	-	4
DPG253MJ	Surveying and Navigation Systems	Major	2	-	1	1	4
Minor-4	Course offered by allied Departments	Minor					4
	Total Credits: 20						

Year-3: Advanced Geospatial techniques

5th SEMESTER

Course Code	Course Title	Category	Hours/Week				Credits
			L	T	P	S	
DPG300MJ	Photogrammetry & Digital Image Processing	Major	1	1	1	1	4
DPG301MJ	Advanced Geospatial Analysis & Modelling	Major	2	1	1	-	4
DPG302MJ	UAV & Laser Terrain Mapping	Major	2	1	1	-	4
DPG303MJ	Web GIS and Mobile Mapping	Major	2	-	1	1	4
Minor-5	Course offered by allied Departments	Minor					4
	Total Credits: 20						

6th SEMESTER

Course Code	Course Title	Category	Hours/Week				Credits
			L	T	P	S	
DPG350MJ	Microwave Remote Sensing	Major	1	1	1	1	4
DPG351MJ	Advanced Remote Sensing Techniques	Major	2	1	1	-	4
DPG352MJ	Hyperspectral and LiDAR Remote Sensing	Major	2	1	1	-	4
Minor-6	Course offered by allied Departments						4
Internship/Community Engagement	Internship/Community Management/NCC/NSS/Adult Education/Student Mentoring/NGO etc.	Internship					4
	Total Credits: 20						

Year-4: Speciality and Research

7th SEMESTER

Course Code	Course Title	Category	Hours/Week				Credits
			L	T	P	S	
DPG400MJ	Spatial Data Infrastructure	Major	2	1	1	0	4
DPG401MJ	Big Data Analytics in Geoinformatics	Major	2	1	1	-	4
DPG402MJ	AI/ML Applications in Geoinformatics	Major	2	1	1	-	4
Minor-7	Course offered by allied Departments	Minor					4
	Research Ethics & Methodology	Research Ethics & Methodology					4
	Total Credits: 20						

8th SEMESTER (Honors)

Course Code	Course Title	Category	Hours/Week				Credits
			L	T	P	S	
DPG450MJ	Geospatial Analytics and Decision Support Systems	Major	1	1	1	1	4
DPG451MJ	Geospatial Applications in Sustainable Development	Major	2	1	1	-	4
DPG422MJ	Discipline Centric Elective-I	Major	2	1	1	-	4
Minor-8	Course offered by allied Departments	Minor					4
DPG451P	Minor Project	Project	4				
	Total Credits: 20						

8th SEMESTER (Research)

Course Code	Course Title	Category	Credits
DCE-3	Geospatial Analytics and Decision Support Systems	Major	4
Minor-8	Course offered by allied Departments		4
DPG500P	Research Project	Research Project	12
Total Credits: 20			

Annexure-I

List of Discipline Centric Electives

I. Geoinformatics for Land Resource Management (4 credits)
Transportation Geoinformatics (4 credits)
I. Geoinformatics for Climate Change Studies (4 credits)
I. Geoinformatics in Water Resources (4 credits)
II. Remote Sensing of Cryosphere (Glaciology) (4 credits)
III. Geoinformatics for Agriculture (4 credits)
IV. Geoinformatics for Disaster Risk Management (4 credits)
V. Geoinformatics in Urban and Regional Planning (4 credits)
VI. Geomorphology and Paleoclimate reconstruction (4 credits)
VII. Geomatics in Geological Applications (4 credits)
VIII. Geoinformatics for Forestry and Wildlife (4 credits)
IX. Geoportal/WebGIS Development (4 credits)
X. Smart Cities: Foundations and Practical (4 credits)
XI. Introduction to Facility Management (4 credits)
XII. Geospatial Approaches to Environmental Sustainability (4 credits)
XIII. Geomatics in Ecosystem Modelling (4 credits)

[1] Minor courses offered by the allied Departments (Data Science/AI)

[2] To be selected from the Multidisciplinary Courses Basket at University Level

[3] To be selected from the Ability Enhancement Courses Basket at University Level

[4] To be selected from the Skill Enhancement Courses Basket at University Level

[5] To be selected from the Value added offered at University Level

Year-1: Foundation in Geospatial sciences & interdisciplinary exposure

1ST SEMESTER

Course Code	Course Title	Category	Hours/Week				Credits
			L	T	P	S	
DPG100MJ	Introduction to Space Technology & Earth Observation	Major	2	1	1	-	4
Minor-1	Course offered by allied Departments	Minor[1]					4
DOMS100MD	Statistical Methods	Multidisciplinary[2]					3
DOELL100AE	Technical Writing	Ability Enhancement[3]					3
DJMC100SE	Multimedia Editing	Skill Enhancement[4]					2
VAC-1	Digital & Technological Solutions	Value added[5]					2
CVS100VA	Health & wellness						2
	Total Credits: 20						

Course Code: DPG100MJ	**L**	**T**	**P**	**S**	**Credits**
Course title: Introduction to Space Technology & Earth Observation	2	1	1	-	04

Course Objectives:

- Understand the history and evolution of space technology and Earth observation, including key milestones and pioneering missions.
- Identify and differentiate between various types of satellites, their sensors, and their applications in Earth observation, communication, navigation, and scientific research.
- Gain foundational knowledge about the principles of remote sensing and major international space agencies' contributions to Earth observation and space technology.

Course Outcome:

By the end of the course, students will be able to:

- Explain the historical evolution and technological advancements in space technology and Earth observation.
- Demonstrate a foundational understanding of Earth Observation.
- Describe the role of space technology in societal applications like disaster management, navigation, and environmental monitoring.
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Module 1: Fundamentals of Space Technology

Fundamentals of Space Technology, Kepler's laws, History and evolution of space technology, Types of satellites and their applications, Overview of international space organizations, Basics of satellite sensors: active and passive sensors; Sensor Characteristics: spatial, spectral, temporal and radiometric resolution.

Module 2: Basics of Remote Sensing

Basics of Remote Sensing, Definition and principles of remote sensing, Components of Remote Sensing Platforms, Sensors, and Data Acquisition, Electromagnetic spectrum: relevance to remote sensing, Interaction of electromagnetic radiation with Atmosphere & Earth's surface, Types of remote sensing: optical, thermal, and microwave, Introduction to satellite imagery and data acquisition.

Module 3: Earth Observation Satellite Systems and Missions

History and Evolution of EO: From Early Observations to Modern Satellites, Overview of Satellite Systems: Types and Functions (Communication, Navigation, and EO Satellites), Notable Earth observation and space technology missions, Case Studies: Indian EO Missions (e.g., Cartosat, RISAT, Oceansat) and Global Missions. Compare the characteristics of different EO sensors and selection of suitable RS data for solving geo-spatial problems.

Module 4: Applications of Earth Observation & Space Technology

Environmental Monitoring, Disaster Management, Urban Planning, etc., Satellite-based navigation and positioning systems (e.g., GPS, IRNSS) • Weather forecasting and communication satellites, Introduction to available satellite datasets for processing and analysis.

Books/Resources:

i. Satellite Technology: Principles and Applications, 2nd Edition, Anil K. Maini and Varsha Agrawal
ii. Remote Sensing and Image Interpretation, 7th Edition, Thomas Lillesand, Ralph W. Kiefer, Jonathan Chipman

2^{nd} SEMESTER

Course Code	Course Title	Category	Hours/Week				Credits
			L	T	P	S	
DPG150MJ	Introduction to Mapping and Geospatial Technologies	Major	2	1	1	-	4
Minor-2	Course offered by allied Departments	Minor					4
CDRR100MD	Understanding Natural Disasters	Multidisciplinary					3
DOELL100AE	Communication Skills	Ability Enhancement					3
DOMS201SE	Python Programming	Skill Enhancement					2
CIR150VA	Understanding India	Value added					2
DOMS150VA	Environmental Science						2
	Total Credits: 20						

Course Code: DPG150MJ	**L**	**T**	**P**	**S**	**Credits**
Course Name: Fundamentals of Geospatial Technologies	2	0	1	1	4

Course Objectives:

- Introduction to fundamental concepts of mapping and geospatial technologies, emphasizing their modern-day applications.
- Hands-on experience with tools and techniques for spatial data creation, analysis, and visualization.
- Coverage of key areas including GIS, GPS, Remote Sensing, and Cartography.

Course Outcomes:

By the end of the course, students will be able to:

- Understand the basic concepts and principles behind mapping and geospatial technologies.
- Gain familiarity with key geospatial tools such as GIS, GPS, and Remote Sensing.
- Learn the fundamentals of map design, data collection, and spatial data analysis.
- Be able to apply geospatial technologies in solving real-world problems across different sectors (e.g., urban planning, environmental monitoring).
- Develop a strong foundation for more advanced courses in Geospatial Technology.

Course Contents:

Module I: Introduction to Geospatial Technologies

Understanding Geospatial Technology: Concepts and Definitions, Overview of Key Components: Geographic Information Systems (GIS), Remote Sensing, Global Positioning Systems (GPS), Concept of Geospatial Data: Spatial data Types and Sources: Raster, Vector, and Attribute Data.

Module II: Fundamentals of Mapping and Cartography

Principles of Cartography: Map Design and Interpretation, Types of Maps: Topographic, Thematic, and Cadastral Maps, Map Projections and Coordinate Systems, Map reading and interpretation skills, understanding map symbols, concept of scale and resolution, Introduction to Cartographic Software (QGIS, ArcGIS) for creating maps and visualizations.

Module III: Geographic Information Systems (GIS)

Introduction to GIS, GIS Components: Hardware, Software, Data, People, and Methods**,** Data Collection and Processing in GIS: Collecting Spatial Data (Field Surveying, Remote Sensing)**,** Basic GIS Operations and Applications, Mapping and analysis of satellite imagery for neighbourhood exploration.

Module IV: Practical Applications and Case Studies

Case studies on environmental mapping, Urban planning and Smart cities, Natural resource management etc. , Hands-on project: Mapping neighbourhood (Project planning and execution, Data collection and analysis, Presentation)

Book/Resources

i. Concepts and Techniques of Geographic Information Systems. C. P. Lo, Albert K. W. Yeung
ii. Remote Sensing and Image Interpretation, 7th Edition. Thomas Lillesand, Ralph W. Kiefer, Jonathan Chipman
iii. Cartography: visualization of geospatial data, M. J. Kraak& F.J. Ormeling, Harlow, Essex: Longman.

Year-2: Specialised Geospatial knowledge

3rd SEMESTER

Course Code	Course Title	Category	Hours/Week				Credits
			L	T	P	S	
DPG200MJ	Geoinformation Management	Major	1	1	1	1	4
DPG201MJ	Geospatial Data Bases	Major	2	1	1	-	4
Minor-3	Course offered by allied Departments	Minor					4
CAI101MD	Generative AI/ Managing Disasters	Multidisciplinary					3
DELL201AE	Kashmiri/Urdu Language	Ability Enhancement					2
DOMS200SE	R Software	Skill Enhancement					3
	Total Credits: 20						

Course Code: DPG200MJ	**L**	**T**	**P**	**S**	**Credits**
Course Title: ICT & Programming for Geoinformation Management	2	1	1	-	04

Course Objectives:

- To provide a comprehensive understanding of computer hardware, software, and their uses in geoinformation systems.
- To develop basic programming skills necessary for data handling and geospatial analysis.
- To familiarize students with the techniques and best practices for handling, processing, and analysing geospatial data.

Course Outcome:

By the end of the course, students will be able to:

- Identify and describe the various components of computer systems and their roles in GIS.
- Write basic programs using programming languages relevant to Geoinformation systems.
- Effectively manage and process geospatial data, including converting and compressing data formats.
- Demonstrate proficiency in using GIS software and tools such as ArcGIS and QGIS.

Module 1: Basics of Computers

Introduction to Computers: Characteristics, history, and classification of computers. Hardware Components: Input/output devices, secondary storage devices, and peripherals. Software Types: Operating systems (DOS, Windows, UNIX), translators, interpreters, compilers, and editors.

Module 2: Fundamentals of Programming

Character set, identifiers, keywords, data types, constants, variables, operators, expressions, and statements. Control Statements: If-Else, loops (while, do-while, for), and switch-case statements. Introduction to Programming Languages: Basics of C, Python, Java

Module 3: Geoinformation Data Handling

Ideal computer configurations for satellite data analysis and geospatial modelling. Role of Computers in GIS and Remote Sensing: Data analysis, metadata introduction, importance, and standards. Data Types and Compression: Signed, unsigned, integer, float, double, complex data types, and data compression techniques.

Module 4: Practical Applications

Hands-on Computers, Handling and maintenance of computers. MS Office Tools: Practical use of MS Word, MS Excel, and MS PowerPoint. Data Conversions: Techniques for converting and managing geospatial data.

Books/Resources:

i. Computers in Geography, Maguire. D. J. Addison-Wesley Longman Publishing Co.
ii. Basic Programming with Applications, Jain, V.K. Tata Mc Graw Hill, New Delhi.
iii. Elements of Data Compression.Drozdek, A.Vikas Publishing House Pvt Ltd.
iv. A first course in Computers. Saxena, S. Vikas Publishing House Pvt Ltd.

Course Code: DPG201MJ	**L**	**T**	**P**	**S**	**Credits**
Course Title: Geospatial Data Bases	2	1	1	-	04

Course Objectives:

- Understand the types and sources of geospatial data and their significance in various fields.
- Develop skills in storing, organizing, and managing geospatial data using appropriate database management systems.
- Explore techniques for processing and analyzing geospatial data to extract meaningful information.
- Apply geospatial data management principles in real-world scenarios and projects.

Course Outcome:

By the end of the course, students will be able to:

- Store, organize, and manage geospatial data using database management systems.
- Process and analyze geospatial data to derive meaningful insights using GIS software.
- Implement geospatial data management principles in practical projects.
- Demonstrate proficiency in using GIS software for geospatial data management tasks

Module 1: Fundamentals of Database Management System

Database concepts, database development, implementation and design, Database management system (DBMS): Network DBMS, Hierarchical DBMS, Relational DBMS, Comparison between these DBMS. Editing and Storing GIS databases

Module 2: DBMS Concepts

Concept of Keys in a database. Theoretical and mathematical understanding of database querying: Relational Algebra, Querying using SQL. Steps in database design, GIS Data modelling using Entity Relationship Diagrams. GIS database application development. GIS database application tools.

Module 3: Advanced DBMS: Database Backup, Transaction logs and Properties. Database Recovery, Data Storage and Causes of System failures, Recovery Techniques: Mirroring, Shadow Paging. Data Integrity: Entity Integrity, Referential Integrity and Domain Integrity. Data Security: Requirements and Risks. Role of a database administrator. Granting and Revoking Privileges and Roles.

Module 4: Regional and Global Databases: Global land use datasets, global ecosystem maps, datasets related to vegetation, topography, land use. Agriculture data sets like FAOSTAT etc., global NPP datasets. Global forest datasets AVHRR global forest resource assessment. Global Seeps database. Global topographic data SRTM, ASTER, CartoDEM. Other global datasets like BALANS land cover data, NIMA DCW VMAP0, GEOnet names server, gridded population of the world, Landsat Geo Cover, Introduction to Global and National geospatial data portals including, USGS Earth Explorer NASA Earthdata, Google Earth Engine (GEE), Bhuvan, VEDAS, India Water Portal, Bhoonidhi, Nakshe, MOSDAC etc.

Books/Resources:

i. R. Elmasri, S.B Navathe. Fundamentals of Database Systems, Pearson Education. 2007.
ii. An introduction to Informatics in Organizations Benynon-Davies, P. (2002). Information Systems: Palgrave (formally Macmillan).
iii. An introduction to Database Systems, Date, C. J. (2000). Reading, M.A. Addison-Wesley.
iv. Database Management Systems, Ramakrishnan, R. and J. Gehrke (2003). Boston, M. A, 21 McGraw.
v. Database Model Design: The fundamental Principles Teorey, T.J. (1994). San Mateo, CA, Morgan Kaufmann.

4th SEMESTER

Course Code	Course Title	Category	Hours/Week				Credits
			L	**T**	**P**	**S**	
DPG250MJ	Remote Sensing Techniques & Applications	Major	2	1	1	0	4
DPG251MJ	Spatial Analysis	Major	2	1	1	-	4
DPG252MJ	Digital Cartography	Major	2	1	1	-	4
DPG253MJ	Surveying and Navigation Systems	Major	2	-	1	1	4
Minor-4	Course offered by allied Departments	Minor					4
	Total Credits: 20						

Course Code: DPG250MJ	**L**	**T**	**P**	**S**	**Credits**
Course Title: Remote Sensing Techniques and Application	2	1	1	-	04

Course Objectives:

- Analyse and interpret spectral signatures for various surface features, such as vegetation, water, and soil.
- Explore the characteristics and operational principles of remote sensing satellites and sensors.
- Apply advanced remote sensing techniques for data acquisition, processing, and interpretation in diverse real-world applications.

Course Outcome:

By the end of the course, students will be able to:

- Explain the principles of EMR and their interaction with Earth's surface.
- Analyze and interpret spectral signatures for different surface features.
- Understand the working principles and characteristics of remote sensing sensors.
- Apply remote sensing data to real-world applications using advanced techniques.

Module 1: Electromagnetic Radiation and Spectral Signatures

Introduction to EMR: Wavelength-frequency-energy relationship of EMR, EMR spectrum, and its properties, EMR Interactions: Scattering, absorption, transmission, atmospheric windows, and energy interactions in the atmosphere, Spectral Signatures: Spectral reflectance curves, concept of signatures for different surface features (vegetation, water, soil).

Module 2: Satellites & Sensors

Satellite Characteristics-Orbits: Polar/Non-Polar Orbit vs. Geostationary, Energy Source: Passive vs. Active, Measurement Technique: Scanning; Non-Scanning; Imager; Sounders OM Line scanners, CCD Line and Area scanners. Sensor Characteristics: Spatial, spectral, and temporal resolution; importance and trade-offs in sensor selection. Characteristics of important satellite systems: LANDSAT, SPOT, IRS, MODIS, IKONOS, ASTER, Sentinel, GeoEye, Worldview, (Digital Globe, Maxar) KOMPSAT, CARTOSAT, RISAT etc

Module 3: Data Acquisition and processing:

Data Acquisition Methods: Satellite, aerial, and UAV-based data collection techniques. Data formats: Raster and vector data, and metadata, Pre-processing Techniques: Calibration and atmospheric correction, Geometric correction and resampling techniques, Image Enhancement Techniques: Contrast stretching, histogram equalization, and spatial filtering, Band combinations: RGB composites, true and false color composites, Principal Component Analysis (PCA) for data dimensionality reduction.

Module 4: Image Interpretation and Applications

Visual Interpretation: Techniques for analyzing remote sensing images. Principles of visual image interpretation: elements of visual image interpretation, importance and factors governing the interpretability. Use of ancillary information for satellite data interpretation. Ground Truth Collection: importance, methods, and Ground truth details. Application of Remote sensing: Natural Resource Management, Environmental monitoring, Urban Planning and Disaster management. Applications in Emerging Fields: Energy and Utilities: Renewable energy site selection (solar, wind), power line corridor mapping, and oil/gas exploration; Geospatial Technology for Smart Applications: Integration of IoT with GIS, geospatial AI, and real-time monitoring systems.

Books/Resources:

i. Remote Sensing and Image Interpretation, Lillesand, R. M. and R. W. Kiefer, 1994, 3rd

	Ed. NY: John Wiley and Sons, Inc.
ii.	Introductory Digital Image Processing, A Remote Sensing Perspective, Jensen, J. R., 1996, Upper Sanddle River, Prentice Hall.
iii.	Introduction to Remote Sensing Cracknell, A.P and L.W.B.Hayes, 1993, London: Taylor & Francis.

Course Code: DPG251MJ	**L**	**T**	**P**	**S**	**Credits**
Course Name: Spatial Analysis	2	0	1	1	4

Course Description:

- Introduces advanced concepts and practices in Geographic Information Systems (GIS) for spatial data analysis.
- Explores capabilities of GIS in capturing, analysing, and visualizing geospatial data.
- Emphasizes hands-on experience with GIS tools and techniques, focusing on practical applications.
- Highlights GIS applications in diverse fields, including urban planning, environmental management, Climate Change Impact Assessment

Course Outcomes:

By the end of the course, students will be able to:

- Understand the basic concepts, definitions, and components of GIS.
- Explore different types of GIS data, including vector and raster data models.
- Develop skills in geospatial data acquisition, processing, and management.
- Apply spatial analysis techniques using GIS software.
- Interpret and present geospatial information effectively.

Course Contents:

Module 1: Introduction to GIS

Review of GIS fundamentals: Definitions, Components, Applications, GIS Architecture: Desktop, Web, Mobile, and Cloud GIS platforms, Differences and Uses, GIS Data Models: Vector, Points, Lines, Polygons (Topology, Spatial Relationships), Raster: Grids, Images (Resolution, Resampling), Concept of Attribute Data, GIS Data Quality and Standards: Data Accuracy, Precision, and Error Sources, Standards in GIS Data Management (Metadata, FGDC, ISO Standards)

Module 2: Geospatial Data and Data Collection Methods

Geospatial Data Types and Sources: Primary vs. Secondary Data; Types of Geospatial Data: Satellite Imagery, Aerial Photography, GPS Data, and Sensor Data; Publicly Available Data Sources and Data Portals; Data Collection Methods, Concept of Georeferencing, Common Projections Used in GIS, Spatial Data Infrastructure (SDI): National and Global Data Portals; Integration of Non-Conventional Data Sources (Social Media, Crowdsourcing).

Module 3: GIS Data Analysis and Visualization

Spatial Data Analysis: Vector Analysis: Buffer, Overlay, and Network Analysis; Raster Analysis: Map Algebra, Terrain Analysis (Slope, Aspect); Introduction to Geostatistics (Interpolation, Hot Spot Analysis); Data Visualization and Cartography: Principles of Cartographic Design, Creating Effective Maps (Symbolization, Labeling, Legends), Working with Map Layouts in GIS; Spatial Querying and Data Retrieval: Attribute and Spatial Queries, SQL for GIS. Filtering and Extracting, Temporal GIS: Time-enabled Data Analysis

Module 4: **Applications of GIS in Spatial Analysis**

Urban Analytics: Smart Cities, Infrastructure Planning, Environmental Modelling: Climate Change Impact, Hazard Zonation; Pollution Mapping Monitoring and Modelling; Public Health GIS: Disease Mapping, Resource Allocation.

Book/Resources

i. Concepts and Techniques of Geographic Information Systems. C. P. Lo, Albert K. W. Yeung
ii. Geographic Information Systems and Science - Paul Longley, Mike Goodchild

Course code: DPG252MJ	**L**	**T**	**P**	**S**	**Credits**
Course title: Digital Cartography	2	1	1	-	04

Course Objectives:

- Understand the significance and applications of environmental mapping in various fields.
- Learn the methods and tools used for collecting geospatial data, including field surveys and remote sensing.
- Develop skills to analyze and interpret geospatial data for environmental studies.
- Apply mapping techniques to real-world environmental scenarios and projects.

Course Outcome:

By the end of the course, students will be able to:

- Understand the principles of cartography and digital map-making.
- Use cartographic software and tools for map creation and analysis.
- Apply design principles to create effective and aesthetically pleasing maps.
- Develop and present a complete digital mapping project

Module 1: Map Making

Maps: Introduction, types of maps, uses of maps. Cartography: analogue and digital cartography, cartographic generalizations. Map composition: map design and layout, map scale, legend, annotations. Coordinate systems, Geoid and datum. Map projections: introduction, properties and aspects of map projections, classification of map projections.

Module 2: Data Sources and Visualization

Data sources for mapping: remote sensing, field observations, GPS, maps and other ancillary data. Survey of India (SOI) map index, Use and users of geo-spatial data, National geospatial data policy, Data products w.r.t land surface processes, disasters, EIA and geology. Visualization techniques: Visual exploration for different features/surfaces, virtual reality and scenario mapping, Layout design, typography, color theory, and thematic map creation.

Module 3: Advanced Topics in Digital Cartography

Interactive and Web Mapping: Introduction to online mapping platforms (e.g., Google Maps, Leaflet, Mapbox); 3D Mapping and Visualization: Techniques for creating three-dimensional visualizations; Cartographic Errors and Accuracy: Sources of error and methods for quality assurance; Ethics in Cartography: Privacy, accessibility, and representation in digital mapping.

Module 4: Applied Cartography and Digital Mapping

Creating thematic maps (e.g., choropleth, isarithmic, dot density); Designing maps for specific applications (e.g., urban planning, disaster management, environmental monitoring); Data integration and georeferencing techniques; Developing a complete digital map project (topic of choice); Project includes planning, data collection, map design, and final presentation.

Books/Resources:

i. Remote Sensing and Image Interpretation, Lillesand, R. M. and R. W. Kiefer, 1994, 3rd Ed. NY: John Wiley and Sons, Inc.
ii. Concepts and techniques of Geographic Information System: Lo C.P: Albert. Prentice Hall. Fundamentals of Geographic Information Systems.DeMers, M.N.2002 2 Wiley and Sons, New York.Edition. John.
iii. Elements of Cartography. Robinson, Arthur H., Joel L. Morrison, Phillip C. Muehrcke, A. Jon Kimerling, and Stephen C. Guptill: John Wiley and Sons, New York.
iv. Cartography: visualization of geospatial data, M. J. Kraak& F.J. Ormeling, Harlow, Essex: Longman.

Course Code: DPG253MJ	**L**	**T**	**P**	**S**	**Credits**
Course Title: Surveying and Navigation Systems	1	1	1	1	04

Course Objectives:

- To provide a comprehensive understanding of various GNSS systems.
- To familiarize students with the fundamental principles of satellite-based navigation.
- To introduce both traditional and modern surveying methods and their applications in geospatial data collection.
- To explore practical applications of GNSS in various fields such as agriculture, transportation, and mapping.

Course Outcome:

- Identify and explain the components and functionalities of GNSS systems
- Comprehend the principles of satellite-based navigation, including triangulation and trilateration.
- Perform surveying tasks using both traditional methods (chain, compass, theodolite) and modern tools (total station, DGPS).
- Utilize GNSS technology in real-time kinematic positioning and various applications like agriculture, transportation, and mapping.

Module 1: Introduction to GNSS and GPS

Introduction to GNSS, concept, types, components. Global and Regional GNSS: GPS, GLONASS; Galileo, BeiDou, NavIC etc.; Geo-positioning basic concepts, GPS accuracy, Wave frequencies, error corrections; Ground data collection: spatial and non-spatial data for analysis and modelling; GPS signal interferences. Concepts of DGPS; Applications of GPS in resources surveys, mapping, crustal deformation and navigation.

Module 2: Introduction to Surveying

Geographic data collection, spatial location and reference. Identification of problems during the fieldwork. Basic principles of surveying, Type of surveys: Surveying techniques; Procedure of field survey; Collection of data- issues and challenges; Designing database structure for the data collected.

Module 3: GNSS Applications:

Real-time kinematic (RTK) positioning, GPS applications in agriculture, transportation, and mapping, Integration of GNSS with GIS; Introduction to SBAS, CORS

Module 4: Surveying Techniques

Traditional Field Equipment: Theodolite, Abney Level, Plane Table. Application of latest technology instruments like GPS, 3D Laser Scanners, EDM, Total Station for field mapping. Compilation of data: Data quality assessment, Digitizing and the creation of a geospatial database. Data interpretation by integration of field and remotely sensed data.

Books/Resources:

i. GPS Satellite Surveying, Leick A (1995): 2nd end. Wiley, New york Chicheste Brisbane Toronto Singapore.
ii. GPS Theory and Practice, Hofmann-Wellenhof B, Lichtenegger H: (2007). Springer (5th eds), Wien New York.
iii. Global Positioning System and GIS, An Introduction, Kennedy, M. Ann Arbor, MI,1996. Concepts and techniques of Geographic Information System: Lo C.P: Albert. Prentice Hall.
iv. Advanced Surveying, 2017: Pearson. Gopi Satheesh, R.Sathikumar, N.Madhu

Year-3: Advanced Geospatial techniques

<u>5th SEMESTER</u>

Course Code	Course Title	Category	Hours/Week				Credits
			L	T	P	S	
DPG300MJ	Photogrammetry & Digital Image Processing	Major	1	1	1	1	4
DPG301MJ	Advanced Geospatial Analysis & Modelling	Major	2	1	1	-	4
DPG302MJ	UAV & Laser Terrain Mapping	Major	2	1	1	-	4
DPG303MJ	Web GIS and Mobile Mapping	Major	2	-	1	1	4
Minor-5	Course offered by allied Departments	Minor					4
	Total Credits: 20						

Course Code: DPG300MJ	**L**	**T**	**P**	**S**	**Credits**
Course Name: Photogrammetry & Image Processing	2	1	1	-	4

Course Objectives:

- Provide students with a comprehensive understanding of photogrammetry and advanced image processing techniques.
- Introduce the principles of photogrammetry, digital image analysis, and 3D modelling.
- Familiarize students with data acquisition workflows in photogrammetry.
- Emphasize the integration of photogrammetric data with GIS, LiDAR, and machine learning.
- Explore practical applications in urban planning, agriculture, and environmental monitoring.

Course Outcomes:

By the end of the course, students will be able to:

- Demonstrate knowledge of the fundamental principles, history, and types of photogrammetry.
- Apply stereo photogrammetry techniques to create 3D models and Digital Elevation Models (DEMs).
- Utilize advanced image processing techniques such as filtering, band math, and PCA in data analysis.
- Integrate photogrammetry with LiDAR, GIS, and machine learning for advanced applications.

Module 1: Fundamentals of Photogrammetry

Introduction to Photogrammetry: Principles, history, and types (aerial, terrestrial, drone-based) Photogrammetric Cameras: Image geometry, focal length, and resolution; Stereo Photogrammetry: 3D model creation and DEM extraction; Platforms and Sensors

Module 2: Image Processing Techniques

Uni-variate and multi-variate statistics in Digital Image Processing. Filtering: introduction, high pass filter, low pass filters, density slicing, edge enhancement and detection filters. Band math and ratioing: image indices (VI, NDVI, PVI, SAVI). Principal component analysis (PCA; Artificial Neural Networks and Fuzzy c-means clustering. Classification Accuracy Assessment; Kappa statistics.

Module 3: Photogrammetric Data Acquisition and Applications

Data Acquisition: UAV photogrammetry workflow and flight planning Applications in Urban Planning and Infrastructure Mapping, Precision Agriculture, Environmental Monitoring etc.

Module 4: Emerging Techniques

Integration of Photogrammetry with LiDAR and GIS; Machine Learning in Image Processing

Book/Resources

1. McGlone, J. C. (2013). Manual of Photogrammetry. ASPRS.
2. Mikhail, E. M., Bethel, J. S., & McGlone, J. C. (2001). Introduction to Modern Photogrammetry. Wiley.
3. Richards, J. A., & Jia, X. (2006). Remote Sensing Digital Image Analysis. Springer.

Course Code: DPG301MJ	**L**	**T**	**P**	**S**	**Credits**
Course Name: Advanced Geospatial Analysis & Modelling	2	1	1	-	4

Course Objectives:

- Develop expertise in advanced geospatial analysis and modeling techniques for solving complex spatial problems.
- Apply spatial statistics and geostatistical methods to analyze and interpret spatial data.
- Utilize 3D spatial analysis to explore and visualize multi-dimensional spatial phenomena.
- Implement predictive modelling approaches to forecast spatial trends and patterns.
- Integrate remote sensing data with geospatial methodologies for advanced applications.

Course Outcomes:

By the end of the course, students will be able to:

- Integration of Remote Sensing Data for Advanced Modelling
- Remote Sensing Data Fusion: Combining data from different sources (e.g., optical, radar, LiDAR) for comprehensive analysis and modelling.
- Change Detection: Methods for identifying changes in land use, vegetation, and environmental conditions using remote sensing data.
- Time-Series Analysis: Analyzing temporal changes using remote sensing data, including vegetation indices (NDVI) and land-cover changes.

Module 1: Advanced Spatial Analysis Techniques

Spatial Statistics: Understanding spatial data distributions, autocorrelation, and point pattern analysis; Geostatistical Methods: Introduction to kriging, variogram analysis, and spatial interpolation techniques; Hotspot Analysis; Spatial Regression.

Module 2: 3D Spatial Analysis and Modelling

Modelling; Techniques for visualizing and analyzing three-dimensional spatial data, including terrain models and city models; Tools and methods for spatial queries and analysis in a 3D environment, including viewshed analysis and slope analysis.

Module 3: Predictive Modelling and Machine Learning in Geospatial Analysis

Predictive Modelling, Understanding and applying machine learning algorithms (e.g., Random Forest, SVM) to predict spatial patterns and trends; Spatial Classification: Using supervised and unsupervised learning for land-use classification and feature detection; Deep Learning techniques, including Convolutional Neural Networks (CNNs) for image analysis and object detection in geospatial data.

Module 4: Integration of Remote Sensing Data for Advanced Modelling

Remote Sensing Data Fusion: Combining data from different sources (e.g., optical, radar, LiDAR) for comprehensive analysis and modelling; Change Detection & Time-Series Analysis

Book/Resources

i. Integration of Remote Sensing Data for Advanced Modelling
ii. Remote Sensing Data Fusion: Combining data from different sources (e.g., optical, radar, LiDAR) for comprehensive analysis and modelling.
iii. Change Detection: Methods for identifying changes in land use, vegetation, and environmental conditions using remote sensing data.
iv. Time-Series Analysis: Analyzing temporal changes using remote sensing data, including vegetation indices (NDVI) and land-cover changes.

Course Code: DPG302MJ	**L**	**T**	**P**	**S**	**Credits**
Course Name: UAV & Laser Terrain Mapping	2	1	1	-	4

Course Objectives:

- Introduce students to the innovative use of UAVs and LiDAR technology for terrain mapping and analysis.
- Provide a blend of theoretical discussions, case studies, and practical exercises for comprehensive learning.
- Enable students to understand UAV systems, LiDAR technology, and geospatial tools for data collection, processing, and analysis.
- Develop skills in terrain modelling and its applications in forestry, urban planning, and disaster management.

Course Outcomes:

By the end of the course, students will be able to:

- Define UAV components and explain their role in terrain mapping.
- Describe LiDAR working principles and its applications in generating terrain models.
- Integrate UAVs with LiDAR systems and optimize their usage for data acquisition.
- Perform data processing and generate 3D terrain models using advanced GIS tools

Module 1: Fundamentals of UAVs in Terrain Mapping

Introduction to UAVs; Definition, types, and components of UAVs, History and Evolution: Development of UAV technology and its applications in terrain mapping, Regulatory Framework; Global and regional UAV regulations, airspace management, and safety guidelines, Data Acquisition Basics: Flight planning, mission execution, and UAV sensors (optical, multispectral, hyperspectral).

Module 2: LiDAR Technology and Principles

Introduction to LiDAR: working principles, components (sensor, GPS, IMU), and data acquisition process; Laser Terrain Mapping: fundamentals of laser pulse emission, reflection, and 3D point cloud generation; Types of LiDAR: Airborne LiDAR (ALS), Terrestrial LiDAR (TLS), Mobile LiDAR (MLS); Applications in Terrain Analysis: Digital elevation models (DEMs), canopy mapping, and hydrological studies.

Module 3: Integration of UAVs with Laser Technology

UAV-LiDAR Systems: Hardware integration, sensor configurations, and operational workflow; Data Collection Techniques: Best practices for UAV-LiDAR surveys, altitude considerations, and coverage optimization; Accuracy and Calibration: Georeferencing, ground control points (GCPs), and error minimization; applications in forestry, urban planning, and disaster management.

Module 4: Data Processing and Applications

Point Cloud Processing: Filtering, classification, and segmentation of LiDAR data; 3D Terrain Modeling: DEM and DTM generation, slope, and aspect analysis; Advanced Analytical Tools: Integration with GIS software (ArcGIS, QGIS) and Machine Learning for feature extraction; Emerging Trends: AI applications, autonomous UAV systems, and future advancements in UAV and laser mapping.

Book/Resources

i. Introduction to UAV Systems" by Paul G. Fahlstrom and Thomas J. Gleason
ii. Principles of LiDAR Remote Sensing" by Robert J. Kimerling and John A. Stubbins.
iii. Digital Elevation Model Technologies and Applications" by David F. Maune
iv. Remote Sensing and GIS Integration" by Michael F. Goodchild

Course Code: DPG303MJ	**L**	**T**	**P**	**S**	**Credits**
Course Name: Web GIS and Mobile Mapping	2	1	1	-	4

Course Objectives:

- Introduce the principles and architecture of Web GIS and mobile mapping technologies.
- Explore tools like ArcGIS Online and OpenLayers for Web GIS applications.
- Develop skills in real-time data collection using mobile mapping systems.
- Enable students to create Web GIS applications using programming languages and databases, with applications in urban planning, environmental monitoring, and disaster management.

Course Outcomes:

By the end of the course, students will be able to:

- Understand the architecture, components, and benefits of Web GIS platforms.
- Utilize mobile mapping technologies for field data collection and real-time applications.
- Apply Web GIS and mobile mapping tools to urban, environmental, and disaster management scenarios.
- Develop basic Web GIS applications using HTML, JavaScript, Leaflet API, and geospatial databases.

Module 1: Introduction to Web GIS

Basics of Web GIS: Architecture, components, and advantages; Web GIS Platforms: ArcGIS Online, Google Maps API, OpenLayers; Spatial Data on the Web: WMS, WFS, and WCS services

Module 2: Mobile Mapping Technologies

Introduction to Mobile Mapping: GPS, GNSS, and mobile sensors; Mobile Mapping Systems: Platforms, workflows, and software; Real-Time Data Collection: Applications in field mapping and ground trothing.

Module 3: Web GIS Applications

Urban and Environmental Monitoring; Crowdsourced GIS and Participatory Mapping Mobile Mapping in Disaster Management; Field Data Collection Tools: Survey123, Open DataKit (ODK), Collector for ArcGIS

Module 4: Development of Web GIS Applications

Introduction to Web GIS Programming: Basics of HTML, JavaScript, and Leaflet API; Database Management: Storing and querying geospatial data.

Book/Resources

i. Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2015). Geographic Information Systems and Science. Wiley.

ii. Fu, P., & Sun, J. (2011). Web GIS: Principles and Applications. ESRI Press.

6th SEMESTER

Course Code	Course Title	Category	Hours/Week				Credits
			L	**T**	**P**	**S**	
DPG350MJ	Microwave Remote Sensing	Major	1	1	1	1	4
DPG351MJ	Advanced Remote Sensing Techniques	Major	2	1	1	-	4
DPG352MJ	Hyperspectral and LiDAR Remote Sensing	Major	2	1	1	-	4
Minor-6	Course offered by allied Departments						4
Internship/Community Engagement	Internship/Community Management/NCC/NSS/Adult Education/Student Mentoring/NGO etc.	Internship					4
	Total Credits: 20						

Course Code: DPG250MJ	**L**	**T**	**P**	**S**	**Credits**
Course Name: Microwave Remote Sensing	2	1	1	-	4

Course Objectives:

- Understand the principles, systems, and applications of microwave remote sensing.
- Explore radar imaging techniques and sensor-target interactions in the microwave region of the electromagnetic spectrum.
- Integrate microwave data with other remote sensing methods for enhanced analysis.
- Apply microwave remote sensing techniques to land use, vegetation, hydrology, and climate studies.

Course Outcomes:

By the end of the course, students will be able to:

- Understand the principles and components of microwave remote sensing, including SAR systems.
- Analyze sensor and target characteristics, including radar polarization and penetration.
- Model radar backscattering and interpret scattering mechanisms of surface and volume features.
- Apply microwave remote sensing techniques for land use, vegetation, hydrological, and climate studies.

Module 1: Introduction to Microwave Remote Sensing

Microwave region of Electromagnetic spectrum, Historical perspective of microwave remote sensing. Details of the Space-borne and airborne radar systems: ERS/JERS-1/ALOS/ASAR/AIRSAR SAR systems. Advantages and disadvantages of radar remote sensing viz-à-viz optical remote sensing. Definition and concept of SLAR, Synthetic Aperture Radar (SAR). SAR viewing geometry: slant range, ground range, azimuth, look angle, incidence angle, and Local incidence angle. Backscattering coefficient and sigma naught expression of SAR. Radar equation for point and distributed targets.

Module 2: Sensor and Target Characteristics

Concept of wavelength and frequency in SAR, Radar penetration, SAR polarization, Dielectric constant, SAR dependence on dielectric constant w.r.t. angle and frequency. SAR sensitivity to surface roughness, Roughness-frequency dependence, Roughness-incidence angle dependence. Speckle: Definition and causes of speckle in SAR images, speckle removal methods; Lee, Lee-sigma, Frost, Gamma adaptive filters, Multi-looking, InSAR; Topographic influences on radar imaging: shadow, foreshortening and layover, methods for minimizing topographic influences on SAR images.

Module 3: Radar Backscattering Modelling

Backscattering of earth's features, Introduction to radiative transfer theory, some common modeling approaches like discrete, continuous, first order scattering, and second order scattering. Examples of these modeling approaches viz. cloud model and MIMICS model,

Scattering mechanisms of SAR signals with surface (bare soil) and volume (vegetation),

Interferometry: concept and application, base line, repeat pass interferometry, Polarimetry.

Module 4: Applications of Microwave Remote Sensing

Land Use and Land Cover Mapping; Soil Moisture and Vegetation Monitoring; Flood Mapping and Hydrological Studies; Applications in Snow, Glacier, and Ocean Monitoring; Forestry: Woody biomass and tree height estimation; Emerging Trends; PolSAR and Multi-Frequency SAR; Integration with Optical and LiDAR

Data; Microwave Remote Sensing in Climate Studies
Book/Resources i. Satellite microwave remote sensing, Allan, T. D.:Chichester, Ellis Hardwood Microwave remote sensing, Ulaby, F. T., Moore, R. K., Fung, A. K., vol.I, II & III. Massachusetts, Adison Wilsey. ii. Imaging radar for resource survey, Trevett, J. W., Chapman and Hall, London Microwave iii. Remote Sensing and Image Interpretation, Lillesand and Kiefer: John Wiley and Sons,

Course Code: DPG351MJ	**L**	**T**	**P**	**S**	**Credits**
Course Name: Advanced Geoinformatics	2	1	1	x	4

Course Objectives:

- Equip students with advanced knowledge of Geoinformatics, focusing on emerging trends and SDI design.
- Explore contemporary issues in data standardization, GIS design methodology, and integration of socio-economic data for decision-making.
- Teach advanced techniques in interpolation and Digital Elevation Model (DEM) creation.
- Apply Geoinformatics methods to solve complex geospatial challenges across various domains.

Course Outcomes:

By the end of the course, students will be able to:

- Apply advanced geoinformatics concepts to address data quality, scale, and system design challenges.
- Design and manage Spatial Data Infrastructures (SDIs) for data access and sharing.
- Use multi-criteria analysis and advanced spatial modelling, including DEM generation, for decision-making.
- Integrate geospatial data standards and tools for terrain analysis and spatial data management.

Module 1: Advanced Concepts in Geoinformatics

Geoinformatics Overview, Advanced concepts and emerging trends in geospatial data science;

Spatial Data Infrastructure (SDI): Design, development, and management of SDIs for effective geospatial data access; Geospatial Data Standards and Interoperability: OGC standards, INSPIRE, and SDI architectures.

Module 2: Contemporary Issues in Geoinformatics

Emerging trends and scope of Geoinformatics. Technological advancements in Geoinformatics, Information Technology and Sensor technology. Data standardization: Data standards, data quality, Scale issues in RS and GIS. GIS design methodology, design and implementation, technical, manpower and institutional issues.

Module 3: Recent advancements in Geoinformatics Science and applications

Enterprise Geographic Information System (GIS): definition trends, implementation and its applications. GPS data use and importance in geospatial analysis. Data integration in GIS: Socio-economic GIS, integration and application of socio-economic and environmental data, fundamentals of multi-criteria analysis. GIS based decision support system: fundamentals and applications.

Module 4: Interpolation & Digital Elevation Models:

Sampling theory: Geographic data sampling methods Interpolation: Introduction, importance, data sources for interpolation, types of interpolation, Methods for interpolation

Book/Resources:

i. Geoinformatics: Data Model and Data Mining by W.T. Fujiwara & D.E. Oscherwitz.

ii. Principles of Geographic Information Systems by P.A. Burrough, R.A. McDonnell, and C.D. Lloyd.

iii. Spatial Data Infrastructure: Concepts, Methodologies, and Applications by Ian C. Harvey.

**Other resources shall be shared during the course*

Course Code: DPG352MJ	**L**	**T**	**P**	**S**	**Credits**
Course Name: Hyperspectral and LiDAR Remote Sensing	2	1	1	-	4

Course Objectives:

- Introduce students to the fundamentals of hyperspectral and LiDAR remote sensing technologies for earth observation.
- Emphasize the principles of hyperspectral imaging and LiDAR technology, including sensor operations and data acquisition.
- Provide hands-on experience in data pre-processing and integration of these technologies for advanced geospatial applications.
- Equip students with both theoretical knowledge and practical skills for applying hyperspectral and LiDAR technologies in real-world scenarios.

Course Outcomes:

By the end of the course, students will be able to:

- Differentiate between hyperspectral and multispectral imaging and understand the principles of hyperspectral remote sensing.
- Explain LiDAR technology, its components, and types, including terrestrial, airborne, and bathymetric LiDAR systems.
- Perform calibration and pre-processing of hyperspectral and LiDAR data, including noise reduction and dimensionality reduction techniques.
- Integrate hyperspectral and LiDAR data for geospatial applications, such as terrain analysis and environmental monitoring.
- Apply hyperspectral and LiDAR technologies to real-world challenges in earth observation.

Module 1: Fundamentals of Hyperspectral Imaging

Concepts and significance: hyperspectral vs. multispectral; Principles of hyperspectral remote sensing; Sensors and platforms for hyperspectral data collection; Spectral signatures and their interpretation; Hyperspectral sensors; Airborne and space borne hyperspectral sensors AVIRIS, Hyperion, PRISMA, etc.; Sensor specifications and data acquisition.

Module 2: LiDAR Remote Sensing

Principles of LiDAR technology (time-of-flight and waveform LiDAR); LiDAR system components: laser, GPS, IMU, and scanner; Types of LiDAR: terrestrial, airborne, satellite LiDAR systems, Bathymetric & Topographic LiDAR

U**nit 3: Hyperspectral Data Acquisition and Pre-processing**

Sensor calibration; Radiometric, geometric, and atmospheric corrections; Noise reduction techniques: de-striping and radiometric corrections; Dimensionality reduction methods: PCA, MNF, and band selection; Hyperspectral Image Classification; Applications of Hyperspectral Remote Sensing

Unit 4: LiDAR Data Acquisition and Pre-processing

LiDAR point cloud generation and characteristics; Point cloud pre-processing: filtering, noise removal, and alignment; Integration of Hyperspectral and LiDAR Data; Applications of LiDAR in earth.

Book/Resources

i. Hyperspectral Remote Sensing and Spectral Signature Applications" by Prasad S. Thenkabail.
ii. LiDAR Remote Sensing and Applications" by Yanli Wang
iii. Remote Sensing and Image Interpretation" by Thomas M. Lillesand and Ralph W. Kiefer.

Year-4: Speciality and Research

7^{th} SEMESTER

Course Code	Course Title	Category	Hours/Week				Credits
			L	T	P	S	
DPG400MJ	Spatial Data Infrastructure	Major	1	1	1	1	4
DPG401MJ	Big Data Analytics in Geoinformatics	Major	2	1	1	-	4
DPG402MJ	AI/ML Applications in Geoinformatics	Major	2	1	1	-	4
Minor-7	Course offered by allied Departments	Minor					4
	Research Ethics & Methodology	Research Ethics & Methodology					4
	Total Credits: 20						

Course Code: DPG400MJ	**L**	**T**	**P**	**S**	**Credits**
Course Name: Advanced Spatial Data Infrastructure	2	1	1	0	4

Course Objectives:

- To understand the concept of Spatial Data Infrastructure (SDI) and its importance in spatial data management.
- To explore technologies and standards used for building and maintaining SDI.
- To introduce tools and techniques for data sharing, interoperability, and analysis.

Course Outcomes:

By the end of the course, students will be able to:

- Understand the fundamental concepts and components of SDI.
- Apply metadata standards and interoperability protocols (ISO, OGC).
- Use cloud computing and open-source tools for SDI development.
- Develop mechanisms for spatial data sharing and management.

Course Contents:

Module 1: Introduction to SDI

Definition and components of SDI; History and evolution of SDI; Importance of SDI in decision-making and planning; Global and regional examples of SDI.

Module 2: Tools and Standards for Spatial Data Integration

Metadata and its importance in SDI; Standards for data interoperability (OGC, ISO); Cloud and distributed computing in SDI; Open-source tools for SDI development.

Module 3: Spatial Data Sharing and Collaboration

Importance of data sharing in SDI; Mechanisms for data sharing: APIs, web services, and portals; Policies and governance in SDI implementation.

Module 4: Applications of SDI

Urban planning, disaster management, and environmental monitoring; Role of SDI in smart cities; National and global SDI frameworks (e.g., NSDI, INSPIRE, GEOSS).

Book/Resources

i. Geographic Information Systems and Science" by Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind
ii. Spatial Data Infrastructure: Concepts, Cases, and Good Practices" by Ian Masser
iii. Cloud Computing for Geospatial Big Data Analytics" by Himansu Das, Chittaranjan Pradhan, and Nilanjan Dey

Course Code: DPG401MJ	**L**	**T**	**P**	**S**	**Credits**
Course Name: Big Data Analytics in Geoinformatics	2	1	1	x	4

Course Objectives:

- Introduce the principles, tools, and technologies for managing and analyzing large geospatial datasets using Big Data analytics.
- Equip students with skills to process spatial data using platforms like Hadoop, Apache Spark, and NoSQL databases.
- Apply Big Data techniques to real-world applications such as urban planning, environmental monitoring, and disaster management.
- Explore emerging trends in cloud computing, machine learning, and real-time geospatial analytics.

Course Outcomes:

By the end of the course, students will be able to:

- Understand the fundamentals of Big Data and its significance in geoinformatics.
- Be proficient in using Big Data tools and platforms (e.g., Hadoop, Spark) for geospatial data management.
- Apply Big Data techniques to analyze large-scale geospatial datasets for various applications.
- Develop skills in integrating and visualizing Big Data with GIS and remote sensing tools.

Module 1: Introduction to Big Data in Geoinformatics

Big Data concepts, characteristics, and challenges of Big Data (volume, velocity, variety, veracity, and value). Geospatial Big Data, Types of geospatial Big Data, including satellite imagery, GPS data, social media data, and sensor networks; Big Data Technologies, Introduction to Big Data platforms like Hadoop, Apache Spark, and NoSQL databases for geospatial data storage and processing.

Module 2: Tools and Platforms for Geospatial Big Data

Hadoop Ecosystem: Understanding Hadoop and its components (HDFS, MapReduce, YARN); Apache Spark: Introduction to Spark for distributed data processing and analysis; NoSQL Databases, working with NoSQL databases like MongoDB and Cassandra for storing and querying geospatial data; Geospatial Data Storage: Storing large-scale geospatial data using formats like GeoJSON, HDF5, and NetCDF.

Module 3: Data Processing and Analysis Techniques

Data Pre-processing: Techniques for cleaning and transforming geospatial Big Data (data fusion, normalization, and sampling); Geospatial Data Integration: Combining remote sensing data, GIS data, and other spatial data sources; Machine Learning and Big Data: Applying machine learning algorithms to analyze Big Data (clustering, classification, and regression); Data Mining: Techniques for discovering patterns, trends, and anomalies in large geospatial datasets.

Module 4: Applications of Big Data Analytics in Geospatial Sciences

Urban Planning and Smart Cities; Environmental Monitoring; Disaster Management; Social Media and Geospatial Analysis; Real-Time Geospatial Analytics.

Book/Resources

i. Hossain, M. S., & Al-Amin, M. (2020). Big Data Analytics in Geospatial Applications. Springer.

ii. Ghosh, A., & Chakraborty, S. (2021). Geospatial Data Science with Python. Wiley.

Course Code: DPG402MJ	**L**	**T**	**P**	**S**	**Credits**
Course Name: AI/ML Applications in Geoinformatics	2	1	1	x	4

Course Objectives:

- Introduce students to the fundamentals of AI and machine learning in geospatial analysis.
- Teach application of machine learning techniques for classification, object detection, and regression in geospatial contexts.
- Explore AI-driven solutions for environmental monitoring, urban planning, and disaster management.
- Cover emerging trends in deep learning for remote sensing and AI integration with cloud platforms for geospatial data analysis.

Course Outcomes:

By the end of the course, students will be able to:

- Understand the basic concepts and algorithms of AI and ML, including supervised and unsupervised learning.
- Apply machine learning algorithms to geospatial data for tasks such as land use/land cover (LULC) classification and feature detection.
- Gain hands-on experience using AI/ML techniques for environmental monitoring, urban planning, and disaster management.
- Explore emerging trends in AI, including deep learning for remote sensing and integration with cloud platforms for large-scale geospatial analysis.

Module 1: Introduction to AI and Machine Learning

Fundamentals of AI/ML: Concepts, definitions, and types of learning (supervised, unsupervised); Machine Learning Algorithms: Random Forest, SVM, Decision Trees, and K-means clustering; Geospatial Data Processing: Preparing and pre-processing geospatial datasets for analysis.

Unit II: Machine Learning for Geospatial Analysis

Classification Techniques: Supervised classification for LULC mapping, Unsupervised classification for clustering geospatial features; Object Detection: Identifying features such as buildings, roads, and vegetation in satellite imagery; Regression Models: Predicting spatial trends and patterns.

Unit III: Applications of AI/ML in Geoinformatics

Environmental Monitoring: Forest health assessment and biomass estimation; Flood and drought prediction; Urban Planning: Traffic congestion analysis, urban sprawl prediction, and smart city development; Disaster Management: Landslide susceptibility mapping; Damage assessment using AI-based tools.

Unit IV: Emerging Trends and Case Studies

Deep Learning for Remote Sensing: Introduction to Convolutional Neural Networks (CNN) for image classification; Integration of AI with Cloud Platforms: Google Earth Engine, AWS SageMaker, and other tools; Real-world applications of AI/ML for solving spatial problems.

Future Directions: AI in autonomous mapping, climate risk analysis, and geospatial IoT.

Book/Resources

i. OLi, X., & Liu, Y. (2017). Machine Learning for Geospatial Applications. Springer.

ii. Zhang, Y., & Wang, L. (2021). Artificial Intelligence in Geospatial Applications: Theory and Practice. CRC Press.