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ताळगांव पठार,
गोंय – ४०३ २०६
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International Year of Cooperatives 2025
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GU/Acad –PG/BoS -NEP/2025-26/308 Date: 08.08.2025

CIRCULAR

The Academic Council & Executive Council of the University has approved Ordinance OA-35A relating to PG Programmes offered at the University campus and its affiliated Colleges based on UGC 'Curriculum and Credit Framework for Postgraduate Programmes'. Accordingly, the University has proposed introduction of Ordinance OA-35A from the Academic year 2025-2026 onwards.

The Programme structure and syllabus of Semester I and II of the **Master of Science in Remote Sensing and Geographical Information System** Programme approved by the Standing Committee of the Academic Council in its meeting held on 24th & 25th June 2025 is attached.

The Dean & Vice-Dean (Academic) of the School of Earth, Ocean and Atmospheric Sciences are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2025.08.08 14:59:10 +05'30'

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,
1. The Dean, School of Earth, Ocean and Atmospheric Sciences, Goa University.
2. The Vice-Dean (Academic), School of Earth, Ocean and Atmospheric Sciences, Goa University.

Copy to:
1. Chairperson, BoS in Remote Sensing & GIS, Goa University.
2. Programme Director, M.Sc. Remote Sensing and Geographical System, Goa University.
3. Controller of Examinations, Goa University.
4. Assistant Registrar Examinations (PG), Goa University.
5. Director, Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

GOA UNIVERSITY

MASTER OF SCIENCE IN REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM

(Effective from the Academic Year 2025-26)

ABOUT THE PROGRAMME
Established in the academic year 2019, the School of Earth, Ocean, and Atmospheric Sciences (SEOAS) was conceptualized to promote a comprehensive, systems-based approach to understanding the Earth. Moving beyond the compartmentalized study of the lithosphere, atmosphere, hydrosphere, and cryosphere, SEOAS fosters an integrative perspective central to Earth System Science. Recognising the Earth as a dynamic and interconnected system, the school seeks to equip emerging scientists, ranging from oceanographers and atmospheric researchers to Earth scientists and GIS specialists, with the tools and knowledge necessary to address urgent global challenges such as climate change, environmental degradation, and sustainability. A cornerstone of this systems-based education is Remote Sensing and Geographic Information Systems (GIS). These technologies are pivotal for conducting multi-scale geospatial analyses spanning local, regional, and global dimensions and for decoding the complex interactions that define the Earth system. Accordingly, the Remote Sensing and GIS curriculum at SEOAS has been strategically developed to integrate foundational scientific theory with practical, solution-oriented applications. The curriculum merges the core principles of the natural sciences with advanced geospatial technologies to produce meaningful, policy-relevant insights. Remote sensing entails the acquisition of digital data through sensors, which is then processed and visualized to monitor and analyze environmental phenomena. When coupled with GIS, remotely sensed data can be synthesized with in-situ information, enabling powerful spatial analyses and evidence-based decision-making. Together, Remote Sensing and GIS form the analytical backbone of modern Earth observation and modelling efforts. The curriculum is designed to cultivate both technical competence and conceptual depth. A strong foundation in mathematics and linear algebra is emphasized to prepare students for higher-level spatial data analysis. Proficiency in programming languages is also an integral part of the training, ensuring that students are capable of implementing sophisticated remote sensing algorithms and workflows. Furthermore, the programme offers hands-on experience with industry-standard software packages, including ENVI, ERDAS Imagine, ORFEO Toolbox, SNAP, QGIS, and GRASS GIS, thus preparing students for research, policy, and professional careers in the geospatial domain. Crucially, the programme promotes domain awareness, i.e., the ability to contextualize geospatial tools within specific environmental and thematic frameworks. This multidisciplinary and application-driven approach enables students to become skilled remote sensing professionals capable of tackling complex environmental challenges with scientific rigour, technological expertise, and societal relevance.

OBJECTIVES OF THE PROGRAMME
The Remote Sensing and GIS programme at SEOAS aims to equip students with a holistic understanding of Earth system processes through geospatial technologies. It integrates theoretical knowledge with hands-on training in remote sensing, GIS, spatial analysis, and programming to address real-world environmental challenges. Emphasising both scientific rigour and technical proficiency, the programme prepares students for research and professional careers in academia, industry, and public policy, while promoting ethical and sustainable use of geospatial data.

PROGRAMME SPECIFIC OUTCOMES (PSO)	
PSO 1.	Develop systems-based understanding of Earth processes
PSO 2.	Enable spatial data generation, integration and interpretation
PSO 3.	Foster research and innovation in environmental problem-solving
PSO 4.	Prepare students for multidisciplinary career pathways
PSO 5.	Promote ethical and sustainable geospatial practices

PROGRAMME STRUCTURE
M.Sc. in Remote Sensing and Geographical Information System
Effective from Academic Year 2025-26

SEMESTER I				
Discipline Specific Core (DSC) Courses (16 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	RSG-5000	Remote Sensing Techniques and Applications	2T	400
2	RSG-5001	Remote Sensing Techniques and Applications Practical	2P	400
3	RSG-5002	Principles and Applications of GIS	2T	400
4	RSG-5003	Principles and Applications of GIS Practical	2P	400
5	RSG-5004	Satellite Meteorology and Atmospheric Sensing	2T	400
6	RSG-5005	Satellite Meteorology and Atmospheric Sensing Practical	2P	400
7	RSG-5006	Satellite Oceanography	2T	400
8	RSG-5007	Satellite Oceanography Practical	2P	400
Total Credits for DSC Courses in Semester I			**16**	
Discipline Specific Elective (DSE) Course (4 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	RSG-5201	Optical, Infrared and Microwave Remote Sensing	4T	400
2	RSG-5202	Remote Sensing and GIS in Coastal Geomorphology	2T	400
3	RSG-5203	Remote Sensing and GIS in Coastal Geomorphology Practical	2P	400
Total Credits for DSE Courses in Semester I			**4**	
Total Credits in Semester I			**20**	

SEMESTER II				
Discipline Specific Core (DSC) Courses				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	RSG-5008	Digital Image Processing	2T	500
2	RSG-5009	Digital Image Processing Practical	2P	500
3	RSG-5010	Geospatial Analysis and Modelling	2T	500
4	RSG-5011	Geospatial Analysis and Modelling Practical	2P	500
5	RSG-5012	Aerosol Remote Sensing and Atmospheric Dynamics	2T	500
6	RSG-5013	Aerosol Remote Sensing and Atmospheric Dynamics Practical	2P	500
7	RSG-5014	Ocean Optical Modelling	2T	500
8	RSG-5015	Ocean Optical Modelling Practical	2P	500
Total Credits for DSC Courses in Semester II			**16**	
Discipline Specific Elective (DSE) Courses (4 credits)				
Sr. No.	**Course Code**	**Title of the Course**	**Credits**	**Level**
1	RSG-5204	Remote Sensing and Climate	2T	400
2	RSG-5205	Remote Sensing and Climate Practical	2P	400
3	RSG-5206	Geospatial Applications for Water Resource Management	2T	400
4	RSG-5207	Geospatial Applications for Water Resource Management Practical	2P	400
Total Credits for DSE Courses in Semester II			**4**	
Total Credits in Semester II			**20**	

SEMESTER I

Discipline Specific Core Courses

Title of the Course	Remote Sensing Techniques and Applications
Course Code	RSG-5000
Number of Credits	2
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course provides a foundational understanding of remote sensing principles, technologies, and applications, with a focus on data acquisition, sensor types, and practical uses in environmental and resource management.	
Course Outcomes:	Students will be able to,	**Mapped to PSO**
	CO 1. Define the basic concepts and components of remote sensing.	PSO 1
	CO 2. Understand the principles of EMR and its interaction with Earth and the atmosphere	PSO 1
	CO 3. Identify types of remote sensing platforms, sensors, and resolutions.	PSO 1, PSO 2

	CO 4. Explain remote sensing data acquisition, applications, and associated technologies	PSO 3		
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction to Remote Sensing: Definition, Scope, and Historical Evolution; Principles of Remote Sensing and Electromagnetic Radiation; Components of Remote Sensing including active and passive remote sensing; Transmission of Electromagnetic Radiation and its Interaction with Earth's Surface; Propagation of Reflected/Emitted Energy through Atmosphere.	**15**	CO 1, CO 2	K1, K2
Module 2:	Types of Remote Sensing Platforms; Types of Sensors and bands; Concepts of pixel, swath, Spatial, Spectral, Temporal, and Radiometric Resolution; Data Acquisition in Remote Sensing; Applications of Remote Sensing; Advantages and Limitations of Remote Sensing; In-situ and Remote Sensor Technologies and UAV Applications.	**15**	CO 3, CO 4	K1, K2
Pedagogy:	Use of Conventional, Online and ICT Methods. Lecture / Tutorials / Assignments			
Texts:	1. Campbell, J. B., & Wynne, R. H. (2011). *Introduction to Remote Sensing.* New York: The Guilford Press. 2. Chuvieco, E. (2016). *Fundamentals of Satellite Remote Sensing.* Boca Raton, Florida: CRC Press. 3. Jensen, J. R. (2015). *Remote Sensing of the Environment: An Earth Resource Perspective. Boston, Massachusetts: Pearson.* 4. Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2014). *Remote Sensing and Image Interpretation.* Hoboken, New Jersey: Wiley. 5. Mobley, C. D. (1994). *Light and Water: Radiative Transfer in Natural Waters. San Diego, California: Academic Press.* 6. Richards, J. A. (2022). *Remote Sensing Digital Image Analysis.* Cham, Switzerland: Springer.			
References/ Readings:	1. Mulla, D. J. (2013). Twenty-five years of remote sensing in precision agriculture: Key advances and remaining knowledge gaps. *Biosystems Engineering, 114*(4), 358–371. https://doi.org/10.1016/j.biosystemseng.2012.08.009 2. Pinter Jr., P. J., Hatfield, J. L., Schepers, J. S., Barnes, E. M., Moran, M. S., Daughtry, C. S. T., & Upchurch, D. R. (2003). Remote sensing for crop management. *Photogrammetric Engineering & Remote Sensing, 69*(6), 647–664. https://doi.org/10.14358/PERS.69.6.647 3. Rogan, J., & Chen, D. (2004). Remote sensing technology for mapping and monitoring land-cover and land-use			

	change. *Progress in Planning*, *61*(4), 301–325. https://doi.org/10.1016/S0305-9006(03)00066-7 4. Schowengerdt, R. A. (2007). Remote sensing: Models and methods for image processing. *Remote Sensing of Environment*, 110(3), 300–306. https://doi.org/10.1016/j.rse.2007.03.003 5. Weng, Q. (2012). Remote sensing of impervious surfaces in the urban areas: Requirements, methods, and trends. *Remote Sensing of Environment*, *117*, 34–49. https://doi.org/10.1016/j.rse.2011.02.030
Web Resources:	1. ISRO's Remote Sensing Handbooks (https://www.isro.gov.in/Miscellaneous.html). 2. IOCCG Reports on Ocean Colour Remote Sensing (https://ioccg.org/what-we-do/ioccg-publications/ioccg-reports/). 3. NASA and ESA Satellite Data Portals (https://www.earthdata.nasa.gov/) 4. VEDAS (Visualisation of Earth observation Data and Archival System) https://vedas.sac.gov.in 5. Indian Space Research Organisation. (n.d.). Space Applications Centre: Earth observation, atmospheric studies, and remote sensing programs. https://www.sac.gov.in

Title of the Course	Remote Sensing Techniques and Applications Practical
Course Code	RSG-5001
Number of Credits	2
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil			
Course Objectives:	This course provides practical experience in remote sensing, focusing on image processing, data correction, and spectral analysis for real-world applications in environmental monitoring and resource management.			
Course Outcomes:	Students will be able to,		**Mapped to PSO**	
	CO 1. Understand satellite data and its sources for remote sensing analysis		PSO 1	
	CO 2. Evaluate and integrate remote sensing data for analysis and interpretation.		PSO 1	
	CO 3. Apply conversion techniques for DN values to spectral radiance and reflectance, and analyse spectral signatures		PSO 1, PSO 2	
	CO 4. Analyse and correct satellite data and evaluate spectral ratios and indices		PSO 3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Familiarisation with software packages Panoply/SeaDAS/.SNAP/QGIS/ ERDAS/ArcGIS/Python/MATLAB; Familiarity with remote sensors; Data sources,	**30**	CO 1, CO 2	K2, K3

	metadata and portals; Layer Stacking of Multispectral Imagery; Creating a subset of an image; Band Combination and Colour Composites.			
Module 2:	Conversion of DN values to spectral Radiance & Reflectance; Corrections of Satellite Data, Radiometric Corrections; Atmospheric Correction; Geometric Correction; Analysis of Spectral Reflectance: spectral signature curve, Spectral Ratios & Indices.	**30**	CO 3, CO 4	K3, K4
Pedagogy:	Use of Conventional, Online and ICT Methods. Hands-on Practicals			
Texts:	1. Campbell, J. B., & Wynne, R. H. (2011). *Introduction to Remote Sensing.* New York: The Guilford Press. 2. Chuvieco, E. (2016). *Fundamentals of Satellite Remote Sensing.* Boca Raton, Florida: CRC Press. 3. Jensen, J. R. (2015). *Remote Sensing of the Environment: An Earth Resource Perspective. Boston, Massachusetts: Pearson.* 4. Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2014). *Remote Sensing and Image Interpretation.* Hoboken, New Jersey: Wiley. 5. Mobley, C. D. (1994). *Light and Water: Radiative Transfer in Natural Waters. San Diego, California: Academic Press.* 6. Richards, J. A. (2022). *Remote Sensing Digital Image Analysis.* Cham, Switzerland: Springer.			
References/ Readings:	1. Mulla, D. J. (2013). Twenty-five years of remote sensing in precision agriculture: Key advances and remaining knowledge gaps. *Biosystems Engineering*, *114*(4), 358–371. https://doi.org/10.1016/j.biosystemseng.2012.08.009 2. Pinter Jr., P. J., Hatfield, J. L., Schepers, J. S., Barnes, E. M., Moran, M. S., Daughtry, C. S. T., & Upchurch, D. R. (2003). Remote sensing for crop management. *Photogrammetric Engineering & Remote Sensing*, *69*(6), 647–664. https://doi.org/10.14358/PERS.69.6.647 3. Rogan, J., & Chen, D. (2004). Remote sensing technology for mapping and monitoring land-cover and land-use change. *Progress in Planning*, *61*(4), 301–325. https://doi.org/10.1016/S0305-9006(03)00066-7 4. Schowengerdt, R. A. (2007). Remote sensing: Models and methods for image processing. *Remote Sensing of Environment*, 110(3), 300–306. https://doi.org/10.1016/j.rse.2007.03.003 5. Weng, Q. (2012). Remote sensing of impervious surfaces in the urban areas: Requirements, methods, and trends. *Remote Sensing of Environment*, *117*, 34–49. https://doi.org/10.1016/j.rse.2011.02.030			
Web Resources:	1. ISRO's Remote Sensing Handbooks (https://www.isro.gov.in/Miscellaneous.html). 2. IOCCG Reports on Ocean Colour Remote Sensing (https://ioccg.org/what-we-do/ioccg-publications/ioccg-reports/).			

	3. NASA and ESA Satellite Data Portals (https://www.earthdata.nasa.gov/) 4. VEDAS (Visualisation of Earth observation Data and Archival System) https://vedas.sac.gov.in 5. Indian Space Research Organisation. (n.d.). Space Applications Centre: Earth observation, atmospheric studies, and remote sensing programs. https://www.sac.gov.in

Title of the Course	Principles and Applications of GIS
Course Code	RSG-5002
Number of Credits	2
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil			
Course Objectives:	This course aims to provide students with a foundational understanding of GIS, covering its components, data structures, software frameworks, and real-world applications.			
Course Outcomes:	Students will be able to,		**Mapped to PSO**	
	CO 1. Explain the fundamentals, components, and applications of GIS		PSO 1	
	CO 2. Compare spatial data types, models, and GIS software frameworks		PSO 1	
	CO 3. Understand spatial data errors and geodatabase concepts		PSO 1, PSO 2	
	CO 4. Apply mapping principles and spatial data management techniques		PSO 3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction to GIS: Definitions, Components, History and Evolution, Need and Scope; Interdisciplinary Relations; Application Areas; Current Issues; Trends and Future; GIS	**15**	CO1,	K1, K2

Approved by: Standing Committee of the Academic Council on 24th & 25th June 2025

	software packages: proprietary & open source; Introduction to GIS software framework; Data types: spatial data, non-spatial data; data structures and data models (Raster & Vector); ESRI Shapefile, GDB and higher data storage formats.		CO2	
Module 2:	Types and sources of errors in vector data; Topology; Introduction to Geodatabase and Types of Geodatabases; Georeferencing: Introduction to map projections and geometric transformations; Conversion of existing data (Rasterise / Vectorise); Elements & Principles of Map Layout; Types of Maps (Based on Scale, Purpose and Applications); Submarine groundwater discharge (SGD).	**15**	CO3, CO4	K2, K3
Pedagogy:	Use of Conventional, Online and ICT Methods. Lecture / Tutorials / Assignments			
Texts:	1. Anbazhagan, S., Subramanian, S.K. & Yang, X., editors (2011). *Geoinformatics in Applied Geomorphology*. Boca Raton, Florida: CRC Press. 2. Awange, J. & Kiema, J.B. (2013) Environmental Geoinformatics. In Environmental Science and Engineering. Heidelberg, Germany: Springer. 3. Karimi, H.A., editor (2014). *Big Data: Techniques and Technologies in Geoinformatics*. Boca Raton, Florida: CRC Press. 4. Li, J. (2007). *Geomatics Solutions for Disaster Management* (edited by S. Zlatanova & A. G. Fabbri). Heidelberg, Germany: Springer (p. 444). 5. Longley, P. & Batty, M. (2003). *Advanced Spatial Analysis: The CASA Book of GIS*. Redlands, California: ESRI Press. 6. Sinha, A.K., editor (2006). *Geoinformatics: Data to Knowledge*, Vol. 397. Boulder, Colorado: Geological Society of America. 7. Skidmore, A., editor (2017). *Environmental Modelling with GIS and Remote Sensing*. Boca Raton, Florida: CRC Press.			
References/ Readings:	1. Burrough, P. A. (1986). Principles of geographical information systems for land resources assessment. *International Journal of Geographical Information Systems, 1*(1), 7–15. https://doi.org/10.1080/02693798708927887 2. Goodchild, M. F. (2009). Geographic information systems and science: Today and tomorrow. *Annals of GIS, 15*(1), 3–9. https://doi.org/10.1080/19475680903250715 3. Guo, D., & Mennis, J. (2009). Spatial data mining and geographic knowledge discovery—An introduction. *Computers, Environment and Urban Systems, 33*(6), 403–408.			

	https://doi.org/10.1016/j.compenvurbsys.2009.11.001 4. Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2005). GIS and science: On the influence of geography and geographic information science. *Geographical Analysis, 37*(1), 1–8. https://doi.org/10.1111/j.1538-4632.2005.00697.x 5. Wright, D. J., Goodchild, M. F., & Proctor, J. D. (1997). Demystifying the persistent ambiguity of GIS as "tool" versus "science". *Annals of the Association of American Geographers, 87*(2), 346–362. https://doi.org/10.1111/0004-5608.872057
Web Resources:	1. Esri GIS Dictionary & Education Resources (https://www.esri.com/en-us/what-is-gis) 2. Indian Space Research Organisation. (n.d.). Space Applications Centre: Earth observation, atmospheric studies, and remote sensing programs. https://www.sac.gov.in 3. National Geographic – Geographic Information Systems (GIS) National Geographic Society. (n.d.). *Geographic Information Systems (GIS)* https://education.nationalgeographic.org/resource/geographic-information-system-gis 4. OpenStreetMap – Learn OSM Beginner's Guide LearnOSM. (n.d.). *Beginner's Guide to OpenStreetMap (OSM)* https://learnosm.org/en/beginner/ 5. QGIS Documentation – Introduction to GIS Concepts https://docs.qgis.org/latest/en/docs/gentle_gis_introduction/

Title of the Course	Principles and Applications of GIS Practical
Course Code	RSG-5003
Number of Credits	2
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course aims to provide hands-on experience with GIS and data analysis, focusing on tasks like data visualisation, georeferencing, and vector data creation. Students will gain practical skills in error identification, topology building, and data conversion between raster and vector formats	
Course Outcomes:	Students will be able to,	**Mapped to PSO**
	CO 1. Apply geospatial tools for data handling and visualization	PSO 1
	CO 2. Identify and correct spatial data errors	PSO 1
	CO 3. Apply data conversion and mapping techniques in digital cartography	PSO 1, PSO 2
	CO 4. Create and interpret different types of maps for spatial representation	PSO 3

Approved by: Standing Committee of the Academic Council on 24th & 25th June 2025

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Familiarisation with software packages Panoply/SeaDAS/.SNAP/QGIS/ ERDAS/ArcGIS/Python/MATLAB; Data Visualisation; Map projections and Georeferencing: Transformation methods; Map to image rectification; Image to image registration; Vector data Creation; Working with Attributes; Error identification & Correction; Topology Building.	**30**	CO 1, CO 2	K1, K2, K3
Module 2:	Conversion of existing data (Rasterize/Vectorize). Digital Cartography: Layout Generation; Using Multiple Data Frames; Creation of Different Types of Maps: Topographic Maps, Physical Maps, Thematic maps, Isopleth Maps, Flow Maps.	**30**	CO 3, CO 4	K2, K3
Pedagogy:	Use of Conventional, Online and ICT Methods. Hands-on Practical			
Texts:	1. Anbazhagan, S., Subramanian, S.K. & Yang, X., editors (2011). *Geoinformatics in Applied Geomorphology*. Boca Raton, Florida: CRC Press. 2. Awange, J. & Kiema, J.B. (2013) *Environmental Geoinformatics. In Environmental Science and Engineering*. Heidelberg, Germany: Springer. 3. Karimi, H.A., editor (2014). *Big Data: Techniques and Technologies in Geoinformatics*. Boca Raton, Florida: CRC Press. 4. Li, J. (2007). *Geomatics Solutions for Disaster Management* (edited by S. Zlatanova & A. G. Fabbri). Heidelberg, Germany: Springer 5. Longley, P. & Batty, M. (2003). *Advanced Spatial Analysis: The CASA Book of GIS*. Redlands, California: ESRI Press. 6. Sinha, A.K., editor (2006). *Geoinformatics: Data to Knowledge*, Vol. 397. Boulder, Colorado: Geological Society of America. 7. Skidmore, A., editor (2017). *Environmental Modelling with GIS and Remote Sensing*. Boca Raton, Florida: CRC Press.			
References/ Readings:	1. Burrough, P. A. (1986). Principles of geographical information systems for land resources assessment. *International Journal of Geographical Information Systems*, *1*(1), 7–15. https://doi.org/10.1080/02693798708927887 2. Goodchild, M. F. (2009). Geographic information systems and science: Today and tomorrow. *Annals of GIS*, *15*(1),			

	3–9. https://doi.org/10.1080/19475680903250715 3. Guo, D., & Mennis, J. (2009). Spatial data mining and geographic knowledge discovery—An introduction. *Computers, Environment and Urban Systems, 33*(6), 403–408. https://doi.org/10.1016/j.compenvurbsys.2009.11.001 4. Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2005). GIS and science: On the influence of geography and geographic information science. *Geographical Analysis*, *37*(1), 1–8. https://doi.org/10.1111/j.1538-4632.2005.00697.x 5. Wright, D. J., Goodchild, M. F., & Proctor, J. D. (1997). Demystifying the persistent ambiguity of GIS as "tool" versus "science". *Annals of the Association of American Geographers, 87*(2), 346–362. https://doi.org/10.1111/0004-5608.872057
Web Resources:	1. Esri GIS Dictionary & Education Resources (https://www.esri.com/en-us/what-is-gis) 2. Indian Space Research Organisation. (n.d.). Space Applications Centre: Earth observation, atmospheric studies, and remote sensing programs. https://www.sac.gov.in 3. National Geographic – Geographic Information Systems (GIS) National Geographic Society. (n.d.). *Geographic Information Systems (GIS)* https://education.nationalgeographic.org/resource/geographic-information-system-gis 4. OpenStreetMap – Learn OSM Beginner's Guide LearnOSM. (n.d.). *Beginner's Guide to OpenStreetMap (OSM)* https://learnosm.org/en/beginner/ 5. QGIS Documentation – Introduction to GIS Concepts https://docs.qgis.org/latest/en/docs/gentle_gis_introduction/

Title of the Course	Satellite Meteorology and Atmospheric Sensing
Course Code	RSG-5004
Number of Credits	2
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course introduces the fundamental principles of satellite-based atmospheric sensing and radiative transfer, with a focus on retrieving atmospheric parameters from satellite and ground-based instruments. It includes hands-on training in processing satellite datasets for weather, aerosol, and trace gas analysis, and demonstrates their application in environmental monitoring.	
Course Outcomes:	Students will be able to,	**Mapped to PSO**
	CO 1. Understand satellite-based data processing techniques to retrieve atmospheric parameters such as aerosols, ozone, and temperature profiles.	PSO 1, PSO 2
	CO 2. Understand spatial and temporal patterns in atmospheric data.	PSO 2
	CO 3. Demonstrate understanding of geospatial tools and their application in processing and visualizing atmospheric datasets.	PSO 3

	CO 4. Apply satellite data access and pre-processing techniques to retrieve atmospheric constituents.		PSO 3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Fundamentals of Satellite Meteorology and Atmospheric Sensing; Structure and composition of the atmosphere; Electromagnetic radiation interaction with the atmosphere (absorption, scattering, emission); Radiative transfer principles and sensor characteristics; Overview of meteorological satellites and sensors (e.g., MODIS, AIRS, TROPOMI, OMI, GOSAT, Imager and Sounder INSAT series); Ground-based networks: LIDAR, AERONET; Retrieval of aerosol optical depth, ozone, and vertical profiles.	**15**	CO1	K1, K2
Module 2:	Applications of satellite meteorology, e.g., air quality monitoring, dust storms, and crop burning; Role of remote sensing in weather forecasting and early warning systems; Climate variability and atmospheric dynamics from satellite observations; Case studies: Indian Summer Monsoon, urban pollution events, aerosol transport.	**15**	CO2	K2, K3
Pedagogy:	Use of Conventional, Online and ICT Methods. Lecture/Tutorials/Assignments			
Texts:	1. Ackerman, S. A., & Knox, J. A. (2021). Meteorology: Understanding the atmosphere (5th ed Burlington, Massachusetts: Jones & Bartlett Learning. 2. Campbell, J. B., & Wynne, R. H. (2023). Introduction to remote sensing (6th ed.). New York, New York: The Guilford Press. 3. Elachi, C., & van Zyl, J. J. (2021). Introduction to the physics and techniques of remote sensing (4th ed.). Hoboken, New Jersey: Wiley. 4. Rees, W. G. (2022). Physical principles of remote sensing (4th ed.). Cambridge, United Kingdom: Cambridge University Press. 5. Robinson, P., & Henderson-Sellers, A. (2020). Contemporary climatology (3rd ed.). Abingdon, United Kingdom: Routledge.			
References/ Readings:	1. Holben, B. N., Eck, T. F., Slutsker, I., Tanré, D., Buis, J. P., Setzer, A., ... & Smirnov, A. (1998). AERONET-A federated instrument network and data archive for aerosol characterization. Remote Sensing of Environment, 66(1),			

	1–16. https://doi.org/10.1016/S0034-4257(98)00031-5 2. Joiner, J., Veihelmann, B., Loyola, D., Worden, H. M., Kim, J., Boesch, H., ... & Röckmann, T. (2021). TROPOMI on Sentinel-5 Precursor: first year in operation (AMT/ACP inter-journal SI). 3. King, M. D., Menzel, W. P., Kaufman, Y. J., Tanré, D., Gao, B. C., Platnick, S., ... & Nakajima, T. (2003). Cloud and aerosol properties, precipitable water, and profiles of temperature and water vapor from MODIS. IEEE Transactions on Geoscience and Remote Sensing, 41(2), 442–458. https://doi.org/10.1109/TGRS.2002.808226. 4. Levelt, P. F., van den Oord, G. H., Dobber, M. R., Mälkki, A., Visser, H., de Vries, J., ... & Veefkind, J. P. (2006). The Ozone Monitoring Instrument. IEEE Transactions on Geoscience and Remote Sensing, 44(5), 1093–1101. https://doi.org/10.1109/TGRS.2006.872333 5. Remer, L. A., Kaufman, Y. J., Tanré, D., Mattoo, S., Chu, D. A., Martins, J. V., ... & Holben, B. N. (2005). The MODIS aerosol algorithm, products, and validation. Journal of the Atmospheric Sciences, 62(4), 947–973. https://doi.org/10.1175/JAS3385.1
Web Resources:	1. European Space Agency (ESA). (n.d.). Copernicus Open Access Hub. https://scihub.copernicus.eu/ 2. NASA Earthdata. (n.d.). Earth Observing System Data and Information System (EOSDIS). https://earthdata.nasa.gov 3. NASA Goddard Space Flight Center. (n.d.). AERONET: Aerosol Robotic Network. https://aeronet.gsfc.nasa.gov/ 4. World Meteorological Organization (WMO). (2014). Guide to satellite applications in meteorology and climatology (WMO-No. 1198). https://library.wmo.int/index.php?lvl=notice_display&id=15659

Title of the Course	Satellite Meteorology and Atmospheric Sensing Practical
Course Code	RSG-5005
Number of Credits	2
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course introduces the fundamental principles of satellite-based atmospheric sensing and radiative transfer, with a focus on retrieving atmospheric parameters from satellite and ground-based instruments. It includes hands-on training in processing satellite datasets for weather, aerosol, and trace gas analysis, and demonstrates their application in environmental monitoring.	
Course Outcomes:	Students will be able to,	**Mapped to PSO**
	CO 1. Understand satellite-based data processing techniques to retrieve atmospheric parameters such as aerosols, ozone, and temperature profiles.	PSO 1, PSO 2
	CO 2. Understand spatial and temporal patterns in atmospheric data.	PSO 2
	CO 3. Demonstrate understanding of geospatial tools and their application in processing and visualizing atmospheric datasets.	PSO 3

	CO 4. Apply satellite data access and pre-processing techniques to retrieve atmospheric constituents.		PSO 3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Familiarisation with software packages Panoply/SeaDAS/.SNAP/QGIS/ ERDAS/ArcGIS/Python/MATLAB; Satellite data access, e.g., NASA Giovanni, Copernicus, MODIS/AIRS portals; Data Visualisation and interpretation using standard remote sensing and GIS tools; Retrieval and plotting of AOD, NO_2, and ozone; Profiles of temperature, subsequent estimations of standard meteorological parameters, humidity, Temperature and humidity profiling from AIRS and radiosonde datasets.	**30**	CO 3	K1, K2
Module 2:	Air quality trend analysis using multi-year remote sensing data; Regional event analyses of dust transport, smog and airborne pollutants; Integration of LIDAR and AERONET data in ground validation; Final-project: Analysis of a selected atmospheric event with report and presentation.	**30**	CO 4	K2, K3
Pedagogy:	Use of Conventional, Online and ICT Methods. Hands-on Practical			
Texts:	1. Ackerman, S. A., & Knox, J. A. (2021). Meteorology: Understanding the atmosphere (5th ed Burlington, Massachusetts: Jones & Bartlett Learning. 2. Campbell, J. B., & Wynne, R. H. (2023). Introduction to remote sensing (6th ed.). New York, New York: The Guilford Press. 3. Elachi, C., & van Zyl, J. J. (2021). Introduction to the physics and techniques of remote sensing (4th ed.). Hoboken, New Jersey: Wiley. 4. Rees, W. G. (2022). Physical principles of remote sensing (4th ed.). Cambridge, United Kingdom: Cambridge University Press. 5. Robinson, P., & Henderson-Sellers, A. (2020). Contemporary climatology (3rd ed.). Abingdon, United Kingdom: Routledge.			
References/ Readings:	1. Holben, B. N., Eck, T. F., Slutsker, I., Tanré, D., Buis, J. P., Setzer, A., ... & Smirnov, A. (1998). AERONET-A federated instrument network and data archive for aerosol characterization. Remote Sensing of Environment, 66(1), 1–16. https://doi.org/10.1016/S0034-4257(98)00031-5			

	2. Joiner, J., Veihelmann, B., Loyola, D., Worden, H. M., Kim, J., Boesch, H., ... & Röckmann, T. (2021). TROPOMI on Sentinel-5 Precursor: first year in operation (AMT/ACP inter-journal SI). 3. King, M. D., Menzel, W. P., Kaufman, Y. J., Tanré, D., Gao, B. C., Platnick, S., ... & Nakajima, T. (2003). Cloud and aerosol properties, precipitable water, and profiles of temperature and water vapor from MODIS. IEEE Transactions on Geoscience and Remote Sensing, 41(2), 442–458. https://doi.org/10.1109/TGRS.2002.808226. 4. Levelt, P. F., van den Oord, G. H., Dobber, M. R., Mälkki, A., Visser, H., de Vries, J., ... & Veefkind, J. P. (2006). The Ozone Monitoring Instrument. IEEE Transactions on Geoscience and Remote Sensing, 44(5), 1093–1101. https://doi.org/10.1109/TGRS.2006.872333 5. Remer, L. A., Kaufman, Y. J., Tanré, D., Mattoo, S., Chu, D. A., Martins, J. V., ... & Holben, B. N. (2005). The MODIS aerosol algorithm, products, and validation. Journal of the Atmospheric Sciences, 62(4), 947–973. https://doi.org/10.1175/JAS3385.1
Web Resources:	1. European Space Agency (ESA). (n.d.). Copernicus Open Access Hub. https://scihub.copernicus.eu/ 2. NASA Earthdata. (n.d.). Earth Observing System Data and Information System (EOSDIS). https://earthdata.nasa.gov 3. NASA Goddard Space Flight Center. (n.d.). AERONET: Aerosol Robotic Network. https://aeronet.gsfc.nasa.gov/ 4. World Meteorological Organization (WMO). (2014). Guide to satellite applications in meteorology and climatology (WMO-No. 1198). https://library.wmo.int/index.php?lvl=notice_display&id=15659

Title of the Course	Satellite Oceanography
Course Code	RSG-5006
Number of Credits	2
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course introduces the principles of oceanography and large-scale circulation, emphasizing the use of satellite remote sensing to observe physical, biological, and chemical processes in the oceans. It provides training in accessing and interpreting satellite-derived oceanographic parameters and demonstrates their integration with ocean models.	
Course Outcomes:	Students will be able to,	**Mapped to PSO**
	CO 1. Understand the basic concepts of ocean structure, dynamics, and the Earth's climate-ocean interactions.	PSO 1, PSO 2
	CO 2. Use satellite datasets to extract and analyse key ocean parameters such as SST, SSH, ocean colour, and salinity.	PSO 2
	CO 3. Interpret variations in oceanographic processes from satellite observations.	PSO 3
	CO 4. Apply satellite-derived oceanographic data to basic modelling workflows and case studies	PSO 3

	related to climate and ecosystem variability.			
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Fundamentals of Oceanography & General Circulation: Introduction to Oceanography; Physical, chemical, biological, and geological oceanography; Oceanic provinces - Coastal, shelf, deep-sea, upwelling zones; Global Ocean Circulation: Wind-driven circulation; Thermohaline circulation & deep-water formation; Ocean-atmosphere interactions; Role of the ocean in climate systems; Principles of Satellite Oceanography; Satellite Platforms & Sensors.	**15**	CO 1	K1, K2
Module 2:	Satellite-Derived Ocean Variables and retrievals - Radiative transfer models, Sea Surface Temperature, Sea Surface Height and Altimetry, Ocean colour, Ocean salinity, Ocean surface winds & waves; Ocean Currents; Ocean Colour Remote Sensing; Bio-optical models & algorithm selection, and parameters, e.g., cholorophyll-a, non-algal particulates and coloured dissolved organic matter, and photosynthetically active radiation, etc.	**15**	CO 2, CO 3	K1, K2
Pedagogy:	Use of Conventional, Online and ICT Methods. Lecture/Tutorials/Assignments			
Texts:	1. Emery, W. J., & Thomson, R. E. (2014). Data analysis methods in physical oceanography (3rd ed.). Amsterdam, Netherlands: Elsevier. 2. Lalli, C. M., & Parsons, T. R. (1997). Biological oceanography: An introduction (2nd ed.). Oxford, United Kingdom: Butterworth-Heinemann. 3. Mann, K. H., & Lazier, J.R.N. (2013). Dynamics of marine ecosystems: Biological-physical interactions in the oceans (3rd ed.). Chichester, United Kingdom: Wiley-Blackwell. 4. Mobley, C. D. (1994). Light and water: Radiative transfer in natural waters. San Diego, California: Academic Press. 5. Rees, W. G. (2022). Physical principles of remote sensing (4th ed.). Cambridge, United Kingdom: Cambridge University Press.			
References/ Readings:	1. Behrenfeld, M. J., & Falkowski, P. G. (1997). Photosynthetic rates derived from satellite-based chlorophyll concentration. Limnology and Oceanography, 42(1), 1–20. https://doi.org/10.4319/lo.1997.42.1.0001 2. Chelton, D. B., Schlax, M. G., & Samelson, R. M. (2011). Global observations of nonlinear mesoscale eddies.			

	Progress in Oceanography, 91(2), 167–216. https://doi.org/10.1016/j.pocean.2011.01.002 3. Le Traon, P. Y., Nadal, F., & Ducet, N. (1998). An improved mapping method of multisatellite altimeter data. Journal of Atmospheric and Oceanic Technology, 15(2), 522–534. https://doi.org/10.1175/1520-0426(1998)015<0522:AIMMOM>2.0.CO;2 4. McClain, C. R. (2009). A decade of satellite ocean color observations. Annual Review of Marine Science, 1, 19–42. https://doi.org/10.1146/annurev.marine.010908.163650 5. Siegel, D. A., Doney, S. C., & Yoder, J. A. (2002). The North Atlantic spring phytoplankton bloom and Sverdrup's critical depth hypothesis. Science, 296(5568), 730–733. https://doi.org/10.1126/science.1069174
Web Resources:	1. European Union Copernicus Programme. (n.d.). Marine data and services. https://marine.copernicus.eu/ 2. NASA Goddard Space Flight Center. (n.d.). MODIS, SeaWiFS, and VIIRS ocean color data archive. https://oceancolor.gsfc.nasa.gov/ 3. Space Applications Centre (ISRO). (n.d.). Satellite data for oceanographic and meteorological research in India. https://www.mosdac.gov.in/

Title of the Course	Satellite Oceanography Practical
Course Code	RSG-5007
Number of Credits	2
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course introduces the principles of oceanography and large-scale circulation, emphasizing the use of satellite remote sensing to observe physical, biological, and chemical processes in the oceans. It provides training in accessing and interpreting satellite-derived oceanographic parameters and demonstrates their integration with ocean models.	
Course Outcomes:	Students will be able to,	**Mapped to PSO**
	CO 1. Understand the basic concepts of ocean structure, dynamics, and the Earth's climate-ocean interactions.	PSO 1, PSO 2
	CO 2. Use satellite datasets to extract and analyse key ocean parameters such as SST, SSH, ocean colour, and salinity.	PSO 2
	CO 3. Interpret variations in oceanographic processes from satellite observations.	PSO 3
	CO 4. Apply satellite-derived oceanographic data to basic modelling workflows and case	PSO 3

	studies related to climate and ecosystem variability.			
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Familiarisation with software packages Panoply/SeaDAS/.SNAP/QGIS/ ERDAS/ArcGIS/Python/MATLAB; Remote Sensing Data Processing: Accessing Oceanographic Satellite Data; Bhoonidhi-NRSC, Mosdac-SAC of ISRO; INCOIS data sources; NASA Ocean Colour; Copernicus Marine, and NOAA databases; Data Processing & Visualization; extracting time series; Mapping oceanographic features from satellite data.	**30**	CO1	K1, K2
Module 2:	Algorithm Implementation: Ocean colour processing and SST anomaly detection & trend analysis; Field survey for validation of derived products of local estuaries for comparison; Giovanni, SeaDAS, and level-corrections. Final Project: Regional Analysis.	**30**	CO2, CO3	K2, K3
Pedagogy:	Use of Conventional, Online and ICT Methods. Hands-on Practical			
Texts:	1. Emery, W. J., & Thomson, R. E. (2014). Data analysis methods in physical oceanography (3rd ed.). Amsterdam, Netherlands: Elsevier. 2. Lalli, C. M., & Parsons, T. R. (1997). Biological oceanography: An introduction (2nd ed.). Oxford, United Kingdom: Butterworth-Heinemann. 3. Mann, K. H., & Lazier, J.R.N. (2013). Dynamics of marine ecosystems: Biological-physical interactions in the oceans (3rd ed.). Chichester, United Kingdom: Wiley-Blackwell. 4. Mobley, C. D. (1994). Light and water: Radiative transfer in natural waters. San Diego, California: Academic Press. 5. Rees, W. G. (2022). Physical principles of remote sensing (4th ed.). Cambridge, United Kingdom: Cambridge University Press.			
References/ Readings:	1. Behrenfeld, M. J., & Falkowski, P. G. (1997). Photosynthetic rates derived from satellite-based chlorophyll concentration. Limnology and Oceanography, 42(1), 1–20. https://doi.org/10.4319/lo.1997.42.1.0001 2. Chelton, D. B., Schlax, M. G., & Samelson, R. M. (2011). Global observations of nonlinear mesoscale eddies. Progress in Oceanography, 91(2), 167–216. https://doi.org/10.1016/j.pocean.2011.01.002 3. Le Traon, P. Y., Nadal, F., & Ducet, N. (1998). An improved mapping method of multisatellite altimeter data.			

	Journal of Atmospheric and Oceanic Technology, 15(2), 522–534. https://doi.org/10.1175/1520-0426(1998)015<0522:AIMMOM>2.0.CO;2 4. McClain, C. R. (2009). A decade of satellite ocean color observations. Annual Review of Marine Science, 1, 19–42. https://doi.org/10.1146/annurev.marine.010908.163650 5. Siegel, D. A., Doney, S. C., & Yoder, J. A. (2002). The North Atlantic spring phytoplankton bloom and Sverdrup's critical depth hypothesis. Science, 296(5568), 730–733. https://doi.org/10.1126/science.1069174
Web Resources:	1. European Union Copernicus Programme. (n.d.). Marine data and services. https://marine.copernicus.eu/ 2. NASA Goddard Space Flight Center. (n.d.). MODIS, SeaWiFS, and VIIRS ocean color data archive. https://oceancolor.gsfc.nasa.gov/ 3. Space Applications Centre (ISRO). (n.d.). Satellite data for oceanographic and meteorological research in India. https://www.mosdac.gov.in/

Discipline Specific Elective Courses

Title of the Course	Optical, Infrared and Microwave Remote Sensing
Course Code	RSG-5201
Number of Credits	4
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course offers in-depth functioning and applications of optical, infrared, and microwave remote sensing sensors. Students will learn to interpret data from panchromatic, multispectral, hyperspectral, thermal, and microwave systems and apply multi-sensor datasets to environmental, coastal, and disaster applications through case studies.	
Course Outcomes:	Students will be able to,	**Mapped to PSO**
	CO 1. Understand the physical principles governing electromagnetic radiation and its interaction with vegetation, soil, water, and the atmosphere.	PSO 1, PSO 2
	CO 2. Differentiate between optical, infrared, and microwave sensing techniques in terms of platforms, sensors, and spectral properties.	PSO 2
	CO 3. Apply the principles of thermal infrared and microwave sensing to real-world problems	PSO 3

	such as temperature estimation, land surface dynamics, and disaster detection.			
	CO 4. Integrate and analyze multi-sensor datasets (optical, IR, and microwave) for environmental, marine, and hazard mapping applications.	PSO 3		
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Fundamentals of Electromagnetic Radiation and Remote Sensing. Electromagnetic Spectrum; Energy Sources; Laws of Radiation (Planck's, Stefan-Boltzmann, Wien's law); Interaction of EM waves with Atmosphere, Vegetation, Water, and Soil. Atmospheric Scattering and Absorption Effects.	**10**	CO 1	K1, K2
Module 2:	Optical Remote Sensing. Basics of Optical Sensors: Panchromatic, Multispectral, Hyperspectral Imaging; Passive vs. Active Sensors; Optical Sensor Platforms on board Satellites; Image characteristics: Spatial, Spectral, Radiometric, and Temporal Resolution; Application of Optical Remote Sensing.	**15**	CO 2, CO 3, CO 4	K1, K2
Module 3:	Infrared Remote Sensing; Thermal Infrared Radiation and its Properties; Blackbody Radiation, Emissivity, and Temperature Estimation; Thermal Sensors and Platforms; Application of Infrared Remote Sensing; Microwave Remote Sensing; Microwave Spectrum; Active vs. Passive Microwave Remote Sensing; Radar Principles: Scattering mechanisms, Polarization, Backscatter, and Speckle; Radiometer, Scatterometer, and SAR, Altimeter sensors and missions; Applications of Microwave Remote Sensing.	**20**	CO 2, CO 3, CO 4	K1, K2
Module 4:	Data fusion: Combining Optical, Infrared, and Microwave Datasets; Remote Sensing for Disaster Management; Coastal and Marine Applications; Future trends in remote sensing include small satellites, AI/ML integration, and hyperspectral-microwave synergy.	**15**	CO 4	K1, K2, K3
Pedagogy:	Use of Conventional, Online and ICT Methods. Lecture/Tutorials/Assignments			
Texts:	1. Campbell, J. B., & Wynne, R. H. (2023). Introduction to remote sensing (6th ed.). New York, New York: The Guilford Press. 2. Jensen, J. R. (2007). Remote sensing of the environment: An Earth resource perspective (2nd ed.). Upper Saddle River, New Jersey: Pearson. 3. Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). Remote sensing and image interpretation (7th ed.).			

	Hoboken, New Jersey: Wiley. 4. Richards, J. A., & Jia, X. (2006). Remote sensing digital image analysis (4th ed.). Berlin, Germany: Springer. 5. Schott, J. R. (2007). Remote sensing: The image chain approach (2nd ed.). New York, New York: Oxford University Press.
References/ Readings:	1. Bannari, A., Morin, D., Bonn, F., & Huete, A. R. (1995). A review of vegetation indices. Remote Sensing Reviews, 13(1–2), 95–120. https://doi.org/10.1080/02757259509532298 2. McCandless, S. W., & Jackson, C. R. (2004). Ocean radar scatterometry. Proceedings of the IEEE, 92(8), 1421–1431. https://doi.org/10.1109/JPROC.2004.831883 3. Schmugge, T., Kustas, W. P., Ritchie, J. C., Jackson, T. J., & Rango, A. (2002). Remote sensing in hydrology. Advances in Water Resources, 25(8–12), 1367–1385. https://doi.org/10.1016/S0309-1708(02)00065-9 4. Tucker, C. J. (1979). Red and photographic infrared linear combinations for monitoring vegetation. Remote Sensing of Environment, 8(2), 127–150. https://doi.org/10.1016/0034-4257(79)90013-0 5. Ulaby, F. T., Moore, R. K., & Fung, A. K. (1986). Microwave remote sensing: Active and passive. IEEE Transactions on Geoscience and Remote Sensing, 24(3), 389–393. https://doi.org/10.1109/TGRS.1986.289643
Web Resources:	1. European Union Copernicus Programme. (n.d.). Marine data and services. https://marine.copernicus.eu/ 2. NASA Goddard Space Flight Center. (n.d.). MODIS, SeaWiFS, and VIIRS ocean color data archive. https://oceancolor.gsfc.nasa.gov/ 3. Space Applications Centre (ISRO). (n.d.). Satellite data for oceanographic and meteorological research in India. https://www.mosdac.gov.in/

Title of the Course	Remote Sensing & GIS in Coastal Geomorphology
Course Code	RSG-5202
Number of Credits	2
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/Value-added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course aims to impart knowledge on the use of Remote Sensing & GIS for monitoring and managing coastal environments.	
Course Outcomes:	Students will be able to,	**Mapped to PSO**
	CO 1. Understand coastal geomorphology, landforms, and processes	PSO 1, PSO 2
	CO 2. Assess the role of coastal zones in environmental management and evaluate human impacts and hazards	PSO 2
	CO 3. Understand shoreline extraction and spatial modelling techniques	PSO 3
	CO 4. Analyse coastal risks and pollution through case studies	PSO 3

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Introduction to coastal geomorphology and classification of coasts; Overview of coastal landforms and processes (waves, tides, currents, sediment transport, sea-level changes); Importance of coastal zones in environmental management and risk assessment; Human impacts and natural hazards in coastal zones.	**15**	CO 1, CO 2	K1, K2
Module 2:	Techniques for shoreline extraction; Time-series analysis and change detection; Spatial modelling of coastal erosion; flood risk Assessment; Monitoring coastal vegetation; Coastal disaster management; Introduction to integrated coastal zone management; shoreline change analysis.	**15**	CO 3, CO 4	K1, K2, K3
Pedagogy:	Use of Conventional, Online and ICT Methods. Lecture / Tutorials / Assignments			
Texts:	1. Jensen, J. R. (2007). *Remote sensing of the environment: An Earth resource perspective* (2nd ed.). Upper Saddle River, New Jersey: Pearson Prentice Hall. 2. Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). *Remote sensing and image interpretation* (7th ed.). Hoboken, New Jersey: John Wiley & Sons. 3. Maiti, S. (2021). *Remote sensing of coastal environments*. Cham, Switzerland: Springer. 4. Masselink, G., & Hughes, M. G. (2014). *Introduction to coastal processes and geomorphology* (2nd ed.). Abingdon, United Kingdom: Routledge. 5. Thieler, E. R., & Danforth, W. W. (1994). *Historical shoreline mapping (DSAS): Methods and applications*. Reston, Virginia: U.S. Geological Survey.			
References/ Readings:	1. Chand, P., & Acharya, P. (2010). Shoreline change and sea-level rise along the coast of Odisha, East coast of India. *Journal of Coastal Research, 26*(6), 1069–1076. https://doi.org/10.2112/JCOASTRES-D-10-00053.1 2. Hapke, C. J., Himmelstoss, E. A., Kratzmann, M. G., List, J. H., & Thieler, E. R. (2011). National assessment of shoreline change: Historical shoreline change along the New England and Mid-Atlantic coasts. *U.S. Geological Survey Open-File Report 2010–1118.* https://pubs.usgs.gov/of/2010/1118/ https://coast.noaa.gov/data/docs/digitalcoast/shoreline-mapping.pdf			

	3. Maiti, S., & Bhattacharya, A. K. (2009). Shoreline change analysis and its application to prediction: A remote sensing and statistics-based approach. *Marine Geology, 257*(1–4), 11–23. https://doi.org/10.1016/j.margeo.2008.10.006 4. NOAA Office for Coastal Management. (2020). *Shoreline mapping: Best practices and guidelines*. National Oceanic and Atmospheric Administration 5. Rajawat, A. S., Chauhan, H. B., & Ajai. (2015). Shoreline change analysis using remote sensing and GIS: A case study of the Gulf of Khambhat, India. *Arabian Journal of Geosciences*, *8*(5), 3065–3077. https://doi.org/10.1007/s12517-014-1403-x
Web Resources:	1. European Space Agency (ESA) – Coastal Zones Applications https://www.esa.int/Applications/Observing_the_Earth/Coastal_zones 2. National Centre for Coastal Research: National Assessment of Shoreline Changes https://www.nccr.gov.in/?q=technical-report 3. ISRO – Bhuvan Coastal GIS Applications https://bhuvan.nrsc.gov.in 4. NASA Earth Observatory – Coastal Monitoring https://earthobservatory.nasa.gov 5. NOAA Digital Coast https://coast.noaa.gov/digitalcoast/ 6. USGS Coastal and Marine Hazards and Resources Program https://www.usgs.gov/programs/cmhrp

Title of the Course	Remote Sensing & GIS in Coastal Geomorphology Practical
Course Code	RSG-5203
Number of Credits	2
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course will help in building skills in data processing, feature extraction, risk modelling, and mapping coastal environmental issues.	
Course Outcomes:	Students will be able to,	**Mapped to PSO**
	CO 1. Process and Analyse satellite data for coastal applications	PSO 1, PSO 2
	CO 2. Analyse shoreline features and detect changes using satellite data	PSO 2
	CO 3. Apply models for coastal risk and vulnerability assessment	PSO 3
	CO 4. Analyse and map coastal features and hazards	PSO 3

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Familiarisation with software packages Panoply/SeaDAS/.SNAP/QGIS/ ERDAS/ArcGIS/Python/MATLAB; Downloading and preparing satellite data for coastal applications; Using Multispectral data for detecting coastal features; digitisation and mapping of coastal landforms; Shoreline extraction using manual, semi-automatic and automatic approaches; and Digital Shoreline Assessment System analysis using time-series satellite data.	**30**	CO1, CO2	K1, K2
Module 2:	DEM-based coastal flood risk and inundation mapping; Creating and applying Coastal Vulnerability Index (CVI); Erosion risk modelling; Mapping and Detection of Oil spill; Sediment plume; and algal blooms.	**30**	CO3, CO4	K2, K3
Pedagogy:	Use of Conventional, Online and ICT Methods. Hands-on Practical			
Texts:	1. Jensen, J. R. (2007). Remote sensing of the environment: An Earth resource perspective (2nd ed.). Upper Saddle River, New Jersey: Pearson Prentice Hall. 2. Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). Remote sensing and image interpretation (7th ed.). Hoboken, New Jersey: John Wiley & Sons. 3. Maiti, S. (2021). Remote sensing of coastal environments. Cham, Switzerland: Springer. 4. Masselink, G., & Hughes, M. G. (2014). Introduction to coastal processes and geomorphology (2nd ed.). Abingdon, United Kingdom: Routledge. 5. Thieler, E. R., & Danforth, W. W. (1994). Historical shoreline mapping (DSAS): Methods and applications. Reston, Virginia: U.S. Geological Survey.			
References/ Readings:	1. Chand, P., & Acharya, P. (2010). Shoreline change and sea-level rise along the coast of Odisha, East coast of India. *Journal of Coastal Research*, *26*(6), 1069–1076. https://doi.org/10.2112/JCOASTRES-D-10-00053.1 2. Hapke, C. J., Himmelstoss, E. A., Kratzmann, M. G., List, J. H., & Thieler, E. R. (2011). National assessment of shoreline change: Historical shoreline change along the New England and Mid-Atlantic coasts. *U.S. Geological Survey Open-File Report 2010–1118.* https://pubs.usgs.gov/of/2010/1118/ https://coast.noaa.gov/data/docs/digitalcoast/shoreline-mapping.pdf			

	3. Maiti, S., & Bhattacharya, A. K. (2009). Shoreline change analysis and its application to prediction: A remote sensing and statistics-based approach. *Marine Geology*, *257*(1–4), 11–23. https://doi.org/10.1016/j.margeo.2008.10.006 4. NOAA Office for Coastal Management. (2020). *Shoreline mapping: Best practices and guidelines*. National Oceanic and Atmospheric Administration 5. Rajawat, A. S., Chauhan, H. B., & Ajai. (2015). Shoreline change analysis using remote sensing and GIS: A case study of the Gulf of Khambhat, India. *Arabian Journal of Geosciences, 8*(5), 3065–3077. https://doi.org/10.1007/s12517-014-1403-x
Web Resources:	1. European Space Agency (ESA) – Coastal Zones Applications https://www.esa.int/Applications/Observing_the_Earth/Coastal_zones 2. ISRO – Bhuvan Coastal GIS Applications https://bhuvan.nrsc.gov.in 3. NASA Earth Observatory – Coastal Monitoring https://earthobservatory.nasa.gov 4. NOAA Digital Coast https://coast.noaa.gov/digitalcoast/ 5. USGS Coastal and Marine Hazards and Resources Program https://www.usgs.gov/programs/cmhrp

SEMESTER II

Discipline Specific Core Courses

Title of the Course	Digital Image Processing
Course Code	RSG-5008
Number of Credits	2
Theory/Practical	Theory
Level	500
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	RSG-5000	
Course Objectives:	This course aims to provide students with a comprehensive understanding of digital image processing concepts, including image enhancement, classification, and error correction techniques in remote sensing. Students will also learn about image transformation, classification methods, and accuracy assessment for remote sensing products.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO 1. Explain concepts of digital image processing and data formats	PSO 1, PSO 2
	CO 2. Understand error correction methods and image enhancement techniques	PSO 2
	CO 3. Explore image enhancement and analysis techniques	PSO 3

	CO 4. Analyse image classification methods and assess accuracy		PSO 3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Concepts of Digital Image and Digital Image Processing; Digital Image Data Format; Image data storage and retrieval; Pre-Processing: Radiometric Errors and correction - Correcting remote sensing system detector error; remote sensing atmospheric correction; Geometric Errors and correction - Internal and external Geometric errors; Types of geometric correction; Mosaicking; Image enhancement Techniques - An overview; Image reduction and magnification.	**15**	CO1, CO2	K1, K2
Module 2:	Contrast Enhancement - Linear and non-linear, Band Rationing; Spatial filtering and Edge enhancement; Density slicing, Multi image manipulation - addition, subtraction; Principal Component Analysis; Principles of Image Classification; Image Classification process, supervised image classification, unsupervised image classification; Classification algorithms; Fuzzy classification; Microwave and thermal image processing; Fourier Transform and Wavelet analysis; Object-oriented Image Segmentation; Concept of Accuracy Assessment; Kappa Analysis.	**15**	CO3, CO4	K2, K3
Pedagogy:	Use of Conventional, Online and ICT Methods. Lecture / Tutorials / Assignments			
Texts:	1. Gonzalez, R. C., & Woods, R. E. (2018). *Digital Image Processing* (4th ed.). London, United Kingdom: Pearson. 2. Dey, N., Bhatt, C. & Ashour, A.S. (2018). *Big Data for Remote Sensing: Visualization, Analysis and Interpretation.* Cham, Switzerland: Springer. 3. Johnston, K., Ver Hoef, J.M., Krivoruchko, K. & Lucas, N. (2001). *Using ArcGIS Geostatistical Analyst*, Vol. 380. Redlands, California: ESRI Press. 4. Reddy, M.A. & Reddy, A. (2008). *Textbook of Remote Sensing and Geographical Information Systems*. Hyderabad, India: BS Publications 5. Scott, L.M. & Janikas, M.V. (2010) Spatial statistics in ArcGIS. In: *Handbook of Applied Spatial Analysis*. Heidelberg, Germany: Springer. 6. Wong, D.W.S. & Lee, J. (2005). *Statistical Analysis of Geographic Information with ArcView GIS and ArcGIS.* Hoboken, New Jersey: John Wiley & Sons			

References/ Readings:	1. Cheng, G., Huang, Y., Li, X., Lyu, S., Xu, Z., Zhao, Q., & Xiang, S. (2023). Change detection methods for remote sensing in the last decade: A comprehensive review. https://doi.org/10.3390/rs16132355. 2. Jensen, J. R. (2005). Introductory digital image processing: A remote sensing perspective. International Journal of Remote Sensing, 26(15), 3335–3336. https://doi.org/10.1080/01431160500112183 3. Liu, C. (2023). A review of digital image processing techniques and future prospects. *International Journal of Computer Science and Information Technology*, *11*(2), 45–59. https://doi.org/10.62051/ijcsit.v4n3.22 4. Lu, D., Mausel, P., Brondízio, E., & Moran, E. (2004). Change detection techniques. *International Journal of Remote Sensing*, *25*(12), 2365–2401. https://doi.org/10.1080/0143116031000139863 5. Mather, P. M. (2004). Computer processing of remotely-sensed images: An introduction. *International Journal of Remote Sensing*, *25*(19), 3709–3711. https://doi.org/10.1080/01431160410001688891
Web Resources:	1. ITC – Remote Sensing and Digital Image Processing Course https://www.itc.nl/education/study-finder/remote-sensing-and-digital-image-processing/ 2. Natural Resources Canada – Digital Image Processing https://natural-resources.canada.ca/maps-tools-publications/satellite-elevation-air-photos/digital-image-processing 3. NASA Earthdata – Remote Sensing Overview https://www.earthdata.nasa.gov/learn/earth-observation-data-basics/remote-sensing

Title of the Course	Digital Image Processing Practical
Course Code	RSG-5009
Number of Credits	2
Theory/Practical	Practical
Level	500
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	RSG-5001			
Course Objectives:	This course aims to familiarise students with GIS software, focusing on remote sensing data visualisation, pre-and post-processing protocols, and various image enhancement and classification techniques. Students will also gain hands-on experience in image mosaicking and accuracy assessment.			
Course Outcomes:	Students will be able to,		**Mapped to PSO**	
	CO 1. Apply software tools for the visualisation and processing of remote sensing data		PSO 1, PSO 2	
	CO 2. Perform image enhancement and manage data formats in remote sensing		PSO 2	
	CO 3. Execute image processing techniques for enhancement and classification		PSO 3	
	CO 4. Perform an accuracy assessment and change detection in remote sensing data		PSO 3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Familiarisation with software packages Panoply/SeaDAS/.SNAP/QGIS/ ERDAS/ArcGIS/Python/MATLAB; Visualisation of remote sensing data; pre-	**30**	CO1, CO2	K2, K3

	processing and post-processing protocols; Data formats in physical sciences; Import and export of satellite data to various formats; Image enhancement techniques – image contrast, histogram equalisation and density slicing. Image compression techniques.			
Module 2:	Resolution merge and mosaic; Band Rationing; Filtering techniques; Principal Component Analysis; Classification supervised and unsupervised; Recoding of Pixels; Accuracy Assessment; Change detection.	**30**	CO3, CO4	K2, K3
Pedagogy:	Use of Conventional, Online and ICT Methods. Hands-on Practicals			
Texts:	1. Gonzalez, R. C., & Woods, R. E. (2018). *Digital Image Processing* (4th ed.). London, United Kingdom: Pearson. 2. Dey, N., Bhatt, C. & Ashour, A.S. (2018). *Big Data for Remote Sensing: Visualization, Analysis and Interpretation.* Cham, Switzerland: Springer. 3. Johnston, K., Ver Hoef, J.M., Krivoruchko, K. & Lucas, N. (2001). *Using ArcGIS Geostatistical Analyst*, Vol. 380. Redlands, California: ESRI Press. 4. Reddy, M.A. & Reddy, A. (2008). *Textbook of Remote Sensing and Geographical Information Systems*. Hyderabad, India: BS Publications 5. Scott, L.M. & Janikas, M.V. (2010) Spatial statistics in ArcGIS. In: *Handbook of Applied Spatial Analysis*. Heidelberg, Germany: Springer. 6. Wong, D.W.S. & Lee, J. (2005). *Statistical Analysis of Geographic Information with ArcView GIS and ArcGIS.* Hoboken, New Jersey: John Wiley & Sons			
References/ Readings:	1. Jensen, J. R. (2005). Introductory digital image processing: A remote sensing perspective. International Journal of Remote Sensing, 26(15), 3335–3336. https://doi.org/10.1080/01431160500112183 2. Mather, P. M. (2004). Computer processing of remotely-sensed images: An introduction. *International Journal of Remote Sensing*, *25*(19), 3709–3711. https://doi.org/10.1080/01431160410001688891 3. Lu, D., Mausel, P., Brondízio, E., & Moran, E. (2004). Change detection techniques. *International Journal of Remote Sensing*, *25*(12), 2365–2401. https://doi.org/10.1080/0143116031000139863 4. Liu, C. (2023). A review of digital image processing techniques and future prospects. *International Journal of Computer Science and Information Technology*, *11*(2), 45–59. https://doi.org/10.62051/ijcsit.v4n3.22 5. Cheng, G., Huang, Y., Li, X., Lyu, S., Xu, Z., Zhao, Q., & Xiang, S. (2023). Change detection methods for remote sensing in the last decade: A comprehensive review. https://doi.org/10.3390/rs16132355.			
Web Resources:	1. ITC – Remote Sensing and Digital Image Processing Course https://www.itc.nl/education/study-finder/remote-			

	sensing-and-digital-image-processing/ 2. Natural Resources Canada – Digital Image Processing https://natural-resources.canada.ca/maps-tools-publications/satellite-elevation-air-photos/digital-image-processing 3. NASA Earthdata – Remote Sensing Overview https://www.earthdata.nasa.gov/learn/earth-observation-data-basics/remote-sensing

Title of the Course	Geospatial Analysis and Modelling
Course Code	RSG-5010
Number of Credits	2
Theory/Practical	Theory
Level	500
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	RSG-5002			
Course Objectives:	This course aims to provide students with an understanding of basic spatial analysis techniques, spatial data acquisition, and database operations, along with advanced methods such as network analysis, spatial interpolation, and surface analysis. Students will also learn about multi-criteria analysis and its applications in site suitability studies.			
Course Outcomes:	Students will be able to,		**Mapped to PSO**	
	CO 1. Explain concepts of spatial data and database management in GIS		PSO 1, PSO 2	
	CO 2. Understand techniques of spatial analysis and data querying		PSO 2	
	CO 3. Describe spatial modelling and analysis techniques in GIS		PSO 3	
	CO 4. Identify principles of network analysis, interpolation, and surface analysis		PSO 3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Basics of Basic Spatial Analysis; Spatial Data Acquisition; Attribute data sources; Spatial and attribute data input; Data storage; RDBMS; database operations; Spatial	**15**	CO1, CO2	K1, K2

	and non-spatial data editing functions; Quality of spatial data; Measurement; Classification & Reclassification; Data Query: Attribute query, Spatial Query, Report Generation from Attribute Data; Vector Data Overlay Analysis: Clip, Merge, Buffering, Union, Erase, Identity, Intersect, Spatial Join; Grid-based Operations: local, focal, zonal and global functions.			
Module 2:	Integration and Modelling: Logic operations, general arithmetic operations, general statistical operations, geometric operations; Network Analysis: Concept & Types of network analysis; Spatial Interpolation: Introduction, Control Points, Thiessen Polygons, IDW, Kriging, Trend surface analysis; Surface analysis: DEM, TIN, Contour, slope, aspect, Hill Shading, Viewshed Analysis and 3D modelling; Multi Criteria Analysis: Introduction, Site suitability Analysis.	**15**	CO3, CO4	K1, K2
Pedagogy:	Use of Conventional, Online and ICT Methods. Lecture / Tutorials / Assignments			
Texts:	1. Anbazhagan, S., Subramanian, S.K. & Yang, X. (2011). *Geoinformatics in Applied Geomorphology*. Boca Raton, Florida: CRC Press. 2. Awange, J. & Kiema, J.B. (2013). *Environmental Geoinformatics. In Environmental Science and Engineering.* Heidelberg, Germany: Springer. 3. Karimi, H.A., editor (2014). *Big Data: Techniques und Technologies in Geoinformatics*. Boca Raton, Florida: CRC Press. 4. Li, J. (2007). *Geomatics Solutions for Disaster Management* (edited by S. Zlatanova & A. G. Fabbri). Heidelberg, Germany: Springer. 5. Longley, P. & Batty, M. (2003). *Enhanced Spatial Analysis: The CASA Book of GIS*. Redlands, California: ESRI Press. 6. Sinha, A.K., (2006). *Geoinformatics: Data to Knowledge*, Vol. 397. Boulder, Colorado: Geological Society of America. 7. Skidmore, A., (2017). *Environmental Modelling with GIS and Remote Sensing*. Boca Raton, Florida: CRC Press.			
References/ Readings:	1. Jiang, B., & Yao, X. (2010). Geospatial analysis and modelling of urban structure and dynamics. In B. Jiang & X. Yao (Eds.), Geospatial Analysis and Modelling of Urban Structure and Dynamics (pp. 1–16). Springer. https://doi.org/10.1007/978-90-481-8572-6_1 2. Weng, Q. (2009). Thermal infrared remote sensing for urban climate and environmental studies: Methods, applications, and trends. ISPRS Journal of Photogrammetry and Remote Sensing, 64(4), 335–344			

	https://doi.org/10.1016/j.isprsjprs.2009.03.007 3. Batty, M. (2007). Editorial: Some thoughts on geospatial analysis and modelling. Computers, Environment and Urban Systems, 31(3), 185–190. https://doi.org/10.1016/j.compenvurbsys.2007.08.001 4. Iyer, R. T., & Krishnan, M. T. (2023). Citation network analysis of geostatistical and machine learning based spatial prediction. Spatial Information Research, 31, 625–636. https://doi.org/10.1007/s41324-023-00526-0 5. Fotheringham, A. S., Brunsdon, C., & Charlton, M. (2002). Geographically weighted regression: The analysis of spatially varying relationships. Wiley.
Web Resources:	1. ESRI – GIS and Spatial Analysis Training https://www.esri.com/training/ 2. Coursera – Geospatial and Environmental Analysis (UC Davis) https://www.coursera.org/learn/geospatial-analysis 3. GIS Lounge - Introduction to Spatial Analysis https://www.gislounge.com/spatial-analysis/ 4. QGIS Tutorials and Tips – Learn Geospatial Analysis with QGIS https://www.qgistutorials.com/en/ 5. Earth Data Science – Geospatial Data Science with Python https://www.earthdatascience.org/

Title of the Course	Geospatial Analysis and Modelling Practical
Course Code	RSG-5011
Number of Credits	2
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	Yes

<table>
<tr><td>Pre-requisites for the Course:</td><td colspan="4">RSG-5003</td></tr>
<tr><td>Course Objectives:</td><td colspan="4">This course aims to provide students with hands-on experience in working with spatial and non-spatial data, performing spatial queries, and conducting overlay and network analysis. Students will also gain practical skills in spatial interpolation, surface analysis, 3D modelling, and site suitability analysis.</td></tr>
<tr><td rowspan="5">Course Outcomes:</td><td colspan="2">Students will be able to,</td><td colspan="2">Mapped to PSO</td></tr>
<tr><td colspan="2">CO 1. Perform data queries, geospatial measurements, and overlay analysis techniques</td><td colspan="2">PSO 1, PSO 2</td></tr>
<tr><td colspan="2">CO 2. Execute network analysis and integrate spatial data</td><td colspan="2">PSO 2</td></tr>
<tr><td colspan="2">CO 3. Apply spatial interpolation and surface analysis techniques</td><td colspan="2">PSO 3</td></tr>
<tr><td colspan="2">CO 4. Perform site suitability analysis using spatial methods</td><td colspan="2">PSO 3</td></tr>
<tr><td>Content:</td><td></td><td>No of hours</td><td>Mapped to CO</td><td>Cognitive Level</td></tr>
<tr><td>Module 1:</td><td>Familiarisation with software packages Panoply/SeaDAS/.SNAP/QGIS/ ERDAS/ArcGIS/Python/MATLAB; Working with Attributes; Linking spatial & non-</td><td>30</td><td>CO1, CO2</td><td>K1, K2, K3</td></tr>
</table>

	spatial data; Data Query: Spatial & Non-spatial Query; Geospatial measurement; Overlay Analysis: Clip, Merge, Buffering, Union, Erase, Identity, Intersect; Network Analysis: Shortest path, Fastest path, Isochrone Maps, Matrix calculation;			
Module 2:	Spatial Interpolation: IDW, Kriging; Surface analysis: DEM and TIN Creation, Contour, slope, aspect, Hill Shading, Viewshed Analysis and 3D modelling; Site suitability Analysis.	**30**	CO3, CO4	K2, K3
Pedagogy:	Use of Conventional, Online and ICT Methods. Hands-on Practical			
Texts:	1. Anbazhagan, S., Subramanian, S.K. & Yang, X. (2011). *Geoinformatics in Applied Geomorphology*. Boca Raton, Florida: CRC Press. 2. Awange, J. & Kiema, J.B. (2013). *Environmental Geoinformatics. In Environmental Science and Engineering.* Heidelberg, Germany: Springer. 3. Karimi, H.A., editor (2014). *Big Data: Techniques und Technologies in Geoinformatics*. Boca Raton, Florida: CRC Press. 4. Li, J. (2007). *Geomatics Solutions for Disaster Management* (edited by S. Zlatanova & A. G. Fabbri). Heidelberg, Germany: Springer. 5. Longley, P. & Batty, M. (2003). *Enhanced Spatial Analysis: The CASA Book of GIS*. Redlands, California: ESRI Press. 6. Sinha, A.K., (2006). *Geoinformatics: Data to Knowledge*, Vol. 397. Boulder, Colorado: Geological Society of America. 7. Skidmore, A., (2017). *Environmental Modelling with GIS and Remote Sensing*. Boca Raton, Florida: CRC Press.			
References/ Readings:	1. Jiang, B., & Yao, X. (2010). Geospatial analysis and modelling of urban structure and dynamics. In B. Jiang & X. Yao (Eds.), Geospatial Analysis and Modelling of Urban Structure and Dynamics (pp. 1–16). Springer. https://doi.org/10.1007/978-90-481-8572-6_1 2. Weng, Q. (2009). Thermal infrared remote sensing for urban climate and environmental studies: Methods, applications, and trends. ISPRS Journal of Photogrammetry and Remote Sensing, 64(4), 335–344 https://doi.org/10.1016/j.isprsjprs.2009.03.007 3. Batty, M. (2007). Editorial: Some thoughts on geospatial analysis and modelling. Computers, Environment and Urban Systems, 31(3), 185–190. https://doi.org/10.1016/j.compenvurbsys.2007.08.001 4. Iyer, R. T., & Krishnan, M. T. (2023). Citation network analysis of geostatistical and machine learning based spatial			

	prediction. Spatial Information Research, 31, 625–636. https://doi.org/10.1007/s41324-023-00526-0 5. Fotheringham, A. S., Brunsdon, C., & Charlton, M. (2002). Geographically weighted regression: The analysis of spatially varying relationships. Wiley.
Web Resources:	1. ESRI – GIS and Spatial Analysis Training https://www.esri.com/training/ 2. Coursera – Geospatial and Environmental Analysis (UC Davis) https://www.coursera.org/learn/geospatial-analysis 3. GIS Lounge – Introduction to Spatial Analysis https://www.gislounge.com/spatial-analysis/ 4. QGIS Tutorials and Tips – Learn Geospatial Analysis with QGIS https://www.qgistutorials.com/en/ 5. Earth Data Science – Geospatial Data Science with Python https://www.earthdatascience.org/

Title of the Course	Aerosol Remote Sensing and Atmospheric Dynamics
Course Code	RSG-5012
Number of Credits	2
Theory/Practical	Theory
Level	500
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	RSG-5004	
Course Objectives:	To provide advanced understanding of aerosol sources, optical properties, and interaction with atmospheric dynamics by enhancing skills in processing and interpreting aerosol data alongside meteorological profiles and reanalysis datasets.	
Course Outcomes:	Students will be able to,	**Mapped to PSO**
	CO 1. Understand the radiative and dynamic effects of aerosols in the atmosphere and their interaction with weather systems.	PSO 1, PSO 2
	CO 2. Understand the retrieval principles of satellite-based aerosol products and validation using AERONET data.	PSO 2
	CO 3. Analyse and apply satellite and reanalysis datasets to study aerosol transport and dynamics.	PSO 3
	CO 4. Analyse multi-sensor datasets for environmental, marine, and hazard mapping applications.	PSO 3

Approved by: Standing Committee of the Academic Council on 24th & 25th June 2025

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Introduction to atmospheric aerosols: sources, types, size distribution, lifetimes; Optical and radiative properties of aerosols: AOD, SSA, AE, asymmetry factor; Satellite-based aerosol sensing from various satellites of space agencies and data portals, and algorithms; Meteorological foundations: atmospheric layers, stability, boundary layer dynamics over land and ocean domains; Role of aerosols in radiation balance and atmospheric thermodynamic characterization.	**15**	CO 1	K1, K2
Module 2:	Coupling of aerosols with meteorological processes (mixing, wind transport, precipitation); AERONET validation: inversion products, quality levels, sky radiance; Case studies: crop burning, haze episodes, dust transport; Aerosol-climate feedbacks and climate model integration; Future trends: machine learning for aerosol type classification, hyperspectral observations	**15**	CO 2, CO 3, CO 4	K2, K3
Pedagogy:	Use of Conventional, Online and ICT Methods. Lecture/Tutorials/Assignments			
Texts:	1. Holton, J. R. (2004). An introduction to dynamic meteorology (4th ed.). Amsterdam, Netherlands: Elsevier Academic Press. 2. Levy, R. C., Remer, L. A., Mattoo, S., Vermote, E. F., & Kaufman, Y. J. (2013). The MODIS aerosol algorithm, products, and validation. In S. A. King (Ed.), Satellite remote sensing of the atmosphere: Techniques and applications (pp. 67–98). Amsterdam, Netherlands: Elsevier 3. Petty, G. W. (2006). A first course in atmospheric radiation (2nd ed.). Madison, Wisconsin: Sundog Publishing. 4. Seinfeld, J. H., & Pandis, S. N. (2016). Atmospheric chemistry and physics: From air pollution to climate change (3rd ed.). Hoboken, New Jersey: Wiley. 5. Wallace, J. M., & Hobbs, P. V. (2006). Atmospheric science: An introductory survey (2nd ed.). Amsterdam, Netherlands: Academic Press			
References/ Readings:	1. Kaufman, Y. J., Tanré, D., & Boucher, O. (2002). A satellite view of aerosols in the climate system. Nature, 419(6903), 215–223. https://doi.org/10.1038/nature01091 2. Levy, R. C., Remer, L. A., et al. (2013). Global evaluation of the Collection 6 MODIS aerosol optical depth retrievals. Atmospheric Measurement Techniques, 6, 2989–3034. https://doi.org/10.5194/amt-6-2989-2013 3. Holben, B. N., et al. (1998). AERONET: A federated instrument network and data archive for aerosol			

	characterization. Remote Sensing of Environment, 66(1), 1-16. https://doi.org/10.1016/S0034-4257(98)00031-5 4. Chin, M., et al. (2009). Atmospheric aerosol properties and climate impacts. Journal of the Atmospheric Sciences, 66(2), 713–731. https://doi.org/10.1175/2008JAS2796.1 5. Torres, O., Bhartia, P. K., Herman, J. R., Sinyuk, A., Holben, B., & Eck, T. F. (2002). A long-term record of aerosol optical depth from TOMS observations and comparison to AERONET measurements. Journal of the Atmospheric Sciences, 59(3), 398–413. https://doi.org/10.1175/1520-0469(2002)059<0398:ALTROA>2.0.CO;2
Web Resources:	1. NASA. (n.d.). MODIS, VIIRS, and TROPOMI aerosol data access. Earth Observing System Data and Information System (EOSDIS). https://earthdata.nasa.gov 2. NASA Goddard Space Flight Center. (n.d.). AERONET: Aerosol monitoring and validation network. https://aeronet.gsfc.nasa.gov 3. European Centre for Medium-Range Weather Forecasts (ECMWF). (n.d.). Atmospheric data including aerosol forecasts and reanalysis. https://atmosphere.copernicus.eu 4. Space Applications Centre (ISRO). (n.d.). Satellite data for meteorology and oceanography. https://www.mosdac.gov.in 5. Indian Space Research Organisation. (n.d.). Space Applications Centre: Earth observation, atmospheric studies, and remote sensing programs. https://www.sac.gov.in

Title of the Course	Aerosol Remote Sensing and Atmospheric Dynamics Practical
Course Code	RSG-5013
Number of Credits	2
Theory/Practical	Practical
Level	500
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	RSG-5005	
Course Objectives:	To provide advanced understanding of aerosol sources, optical properties, and interaction with atmospheric dynamics by enhancing skills in processing and interpreting aerosol data alongside meteorological profiles and reanalysis datasets.	
Course Outcomes:	Students will be able to,	**Mapped to PSO**
	CO 1. Understand the radiative and dynamic effects of aerosols in the atmosphere and their interaction with weather systems.	PSO 1, PSO 2
	CO 2. Understand the retrieval principles of satellite-based aerosol products and validation using AERONET data.	PSO 2
	CO 3. Analyse and apply satellite and reanalysis datasets to study aerosol transport and dynamics.	PSO 3

	CO 4. Analyse multi-sensor datasets for environmental, marine, and hazard mapping applications.		PSO 3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Familiarisation with software packages Panoply/SeaDAS/.SNAP/QGIS/ ERDAS/ArcGIS/Python/MATLAB; Accessing aerosol datasets from various data portals of the space agencies; Online and Offline Visualization of AOD and AE; Processing AERONET data and comparing it with satellite retrievals; Mapping of aerosol products; Meteorological profile analysis using ERA5 (temperature, RH, wind) and other data sets over different domains of land and ocean;	**30**	CO3, CO4	K2, K3
Module 2:	Case study 1: Aerosol plumes over India; Case study 2: CALIPSO-based vertical profiling of dust layers; Time-series analysis of AOD and AQI in urban regions; Wind and boundary layer height overlays with aerosol maps to study transport; Final project: Event-based aerosol-meteorology analysis, report and presentation;	**30**	CO3, CO4	K2, K3, K4
Pedagogy:	Use of Conventional, Online and ICT Methods. Hands-on Practical			
Texts:	1. Holton, J. R. (2004). An introduction to dynamic meteorology (4th ed.). Amsterdam, Netherlands: Elsevier Academic Press. 2. Levy, R. C., Remer, L. A., Mattoo, S., Vermote, E. F., & Kaufman, Y. J. (2013). The MODIS aerosol algorithm, products, and validation. In S. A. King (Ed.), Satellite remote sensing of the atmosphere: Techniques and applications (pp. 67–98). Amsterdam, Netherlands: Elsevier 3. Petty, G. W. (2006). A first course in atmospheric radiation (2nd ed.). Madison, Wisconsin: Sundog Publishing. 4. Seinfeld, J. H., & Pandis, S. N. (2016). Atmospheric chemistry and physics: From air pollution to climate change (3rd ed.). Hoboken, New Jersey: Wiley. 5. Wallace, J. M., & Hobbs, P. V. (2006). Atmospheric science: An introductory survey (2nd ed.). Amsterdam, Netherlands: Academic Press			
References/ Readings:	1. Chin, M., et al. (2009). Atmospheric aerosol properties and climate impacts. Journal of the Atmospheric Sciences, 66(2), 713–731. https://doi.org/10.1175/2008JAS2796.1 2. Holben, B. N., et al. (1998). AERONET: A federated instrument network and data archive for aerosol			

	characterization. Remote Sensing of Environment, 66(1), 1-16. https://doi.org/10.1016/S0034-4257(98)00031-5 3. Kaufman, Y. J., Tanré, D., & Boucher, O. (2002). A satellite view of aerosols in the climate system. Nature, 419(6903), 215–223. https://doi.org/10.1038/nature01091 4. Levy, R. C., Remer, L. A., et al. (2013). Global evaluation of the Collection 6 MODIS aerosol optical depth retrievals. Atmospheric Measurement Techniques, 6, 2989–3034. https://doi.org/10.5194/amt-6-2989-2013 5. Torres, O., Bhartia, P. K., Herman, J. R., Sinyuk, A., Holben, B., & Eck, T. F. (2002). A long-term record of aerosol optical depth from TOMS observations and comparison to AERONET measurements. Journal of the Atmospheric Sciences, 59(3), 398–413. https://doi.org/10.1175/1520-0469(2002)059<0398:ALTROA>2.0.CO;2
Web Resources:	1. European Centre for Medium-Range Weather Forecasts (ECMWF). (n.d.). Atmospheric data including aerosol forecasts and reanalysis. https://atmosphere.copernicus.eu 2. Indian Space Research Organisation. (n.d.). Space Applications Centre: Earth observation, atmospheric studies, and remote sensing programs. https://www.sac.gov.in 3. NASA Goddard Space Flight Center. (n.d.). AERONET: Aerosol monitoring and validation network. https://aeronet.gsfc.nasa.gov 4. NASA. (n.d.). MODIS, VIIRS, and TROPOMI aerosol data access. Earth Observing System Data and Information System (EOSDIS). https://earthdata.nasa.gov 5. Space Applications Centre (ISRO). (n.d.). Satellite data for meteorology and oceanography. https://www.mosdac.gov.in

Title of the Course	Ocean Optical Modelling
Course Code	RSG-5014
Number of Credits	2
Theory/Practical	Theory
Level	500
Effective from AY	2025-2026
New Course	Yes
Bridge Course/Value-added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	RSG-5006	
Course Objectives:	This course introduces the physical and biological foundations of ocean optical modelling and radiative transfer in aquatic environments, with a focus on the bio-optical properties of water constituents like phytoplankton, CDOM, and NAP. It covers theoretical approaches, including empirical, semi-analytical, and physics-based models, and demonstrates the application of inverse modelling and bio-optical algorithms for remote sensing of ocean colour and ecosystem monitoring.	
Course Outcomes:	Students will be able to,	**Mapped to PSO**
	CO 1. Understand the interaction of electromagnetic radiation with seawater and optically active constituents.	PSO 1, PSO 2
	CO 2. Understand radiative transfer theory, absorption, scattering, and light attenuation processes in aquatic systems.	PSO 2
	CO 3. Apply bio-optical models to estimate primary production and light availability in	PSO 3

	different oceanic regimes.			
	CO 4. Interpret satellite-derived ocean colour data using bio-optical algorithms and case-based analysis.	PSO 3		
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Basics of electromagnetic radiation in aquatic media; Interaction of light with water molecules and suspended constituents; Radiative transfer equation (RTE): derivation and physical interpretation; Absorption, scattering, backscattering, and emission in seawater; Photosynthetically available radiation (PAR) and diffuse attenuation coefficient (Kd); Inherent and apparent optical properties (IOPs and AOPs); Phytoplankton ecology and its impact on ocean optics; Optical roles of coloured dissolved organic matter (CDOM) and non-algal particulates (NAP) in oceans, coastal waters and estuaries;	**15**	CO1	K1, K2
Module 2:	Underwater solar transmission, important variables; in-situ instruments and measurement of light underwater, and its physical principles; Optical modelling techniques, and overview empirical, (semi-) analytical, and physics-based models. Inverse modelling method and retrieval of optical properties; Atmospheric correction in ocean colour remote sensing; An overview of algorithms to retrieve chlorophyll-a, CDOM and NAP in open ocean, coastal and estuarine waters.	**15**	CO2, CO3, CO4	K1, K2, K3
Pedagogy:	Use of Conventional, Online and ICT Methods. Lecture/Tutorials/Assignments			
Texts:	1. Babin, M., Roesler, C. S., & Cullen, J. J. (Eds.). (2008). *Real-time coastal observing systems for ecosystem dynamics and harmful algal blooms: Theory, instrumentation and modelling*. Paris, France: UNESCO; Boca Raton, Florida: CRC Press.. 2. IOCCG (International Ocean Colour Coordinating Group). (2000). *Remote sensing of ocean colour in coastal, and other optically complex waters.* (IOCCG Report No. 3). Dartmouth, Nova Scotia, Canada: IOCCG. 3. Kirk, J. T. O. (2011). *Light and photosynthesis in aquatic ecosystems* (3rd ed.). Cambridge, United Kingdom: Cambridge University Press. 4. Lee, Z. (2021). *Remote sensing of aquatic coastal ecosystem processes: Science and management applications*.			

	Cham, Switzerland: Springer. 5. Mobley, C. D. (1994). *Light and water: Radiative transfer in natural waters*. San Diego, California: Academic Press.
References/ Readings:	1. Bricaud, A., Babin, M., Morel, A., & Claustre, H. (1995). Variability in the chlorophyll-specific absorption coefficients of natural phytoplankton: Analysis and parameterization. Journal of Geophysical Research, 100(C7), 13321–13332. https://doi.org/10.1029/95JC00463 2. Gordon, H. R., & Morel, A. (1983). Remote assessment of ocean color for interpretation of satellite visible imagery: A review. Springer-Verlag Lecture Notes in Coastal and Estuarine Studies, 4, 114 pp. 3. Lee, Z., Carder, K. L., & Arnone, R. A. (2002). Deriving inherent optical properties from water color: A multiband quasi-analytical algorithm for optically deep waters. Applied Optics, 41(27), 5755–5772. https://doi.org/10.1364/AO.41.005755 4. Morel, A., & Maritorena, S. (2001). Bio-optical properties of oceanic waters: A reappraisal. Journal of Geophysical Research: Oceans, 106(C4), 7163–7180. https://doi.org/10.1029/2000JC000319 5. Sathyendranath, S., & Platt, T. (1993). Remote sensing of water-column primary production. International Journal of Remote Sensing, 14(3), 593–609. https://doi.org/10.1080/01431169308904360
Web Resources:	1. European Centre for Medium-Range Weather Forecasts (ECMWF). (n.d.). Atmospheric data including aerosol forecasts and reanalysis. https://atmosphere.copernicus.eu 2. Indian Space Research Organisation. (n.d.). Space Applications Centre: Earth observation, atmospheric studies, and remote sensing programs. https://www.sac.gov.in 3. NASA Goddard Space Flight Center. (n.d.). AERONET: Aerosol monitoring and validation network. https://aeronet.gsfc.nasa.gov 4. NASA. (n.d.). MODIS, VIIRS, and TROPOMI aerosol data access. Earth Observing System Data and Information System (EOSDIS). https://earthdata.nasa.gov 5. Space Applications Centre (ISRO). (n.d.). Satellite data for meteorology and oceanography. https://www.mosdac.gov.in

Title of the Course	Ocean Optical Modelling Practical
Course Code	RSG-5015
Number of Credits	2
Theory/Practical	Practical
Level	500
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	This course introduces the physical and biological foundations of ocean optical modelling and radiative transfer in aquatic environments, with a focus on the bio-optical properties of water constituents like phytoplankton, CDOM, and NAP. It covers theoretical approaches, including empirical, semi-analytical, and physics-based models, and demonstrates the application of inverse modelling and bio-optical algorithms for remote sensing of ocean colour and ecosystem monitoring.	
Course Outcomes:	Students will be able to,	**Mapped to PSO**
	CO 1. Apply satellite-based ocean colour data for retrieving chlorophyll, CDOM, and turbidity concentrations.	PSO 1, PSO 2
	CO 2. Implement semi-analytical and empirical models to process and validate ocean optical parameters.	PSO 2
	CO 3. Analyze temporal and spatial trends of ocean colour in different oceanic regimes.	PSO 3

	CO 4. Analyze optical water types and variability.		PSO 3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Familiarisation with software packages Panoply/SeaDAS/.SNAP/QGIS/ ERDAS/ArcGIS/Python/MATLAB; Accessing and downloading satellite datasets from NASA Ocean Color Web; Visualization and processing of L2/L3 reflectance data; Calculation of remote sensing reflectance (Rrs) and derived properties (e.g., Kd, PAR); Applying OCx algorithms for chlorophyll-a concentration; Processing and comparison of CDOM and turbidity using semi-analytical algorithms; Quality control of ocean colour products using climatology and in-situ match-ups; QAA (Quasi-Analytical Algorithm) implementation for deriving IOPs (absorption, backscattering);	**30**	CO 1, CO 2	K2, K3, K4
Module 2:	Time-series analysis of ocean optical parameters in the open ocean; Case study: coastal eutrophication monitoring; Case study: Trends in optically active constituents; OCM Data Analysis; Case study: Influence of upwelling on optical signatures and primary production; Comparative analysis of empirical vs; semi-analytical algorithms; Integration of in-situ data for satellite validation; Spatial-temporal dynamics of one water quality parameter;	**30**	CO 3, CO 4	K2, K3, K4
Pedagogy:	Use of Conventional, Online and ICT Methods. Hands-on Practical			
Texts:	1. Babin, M., Roesler, C. S., & Cullen, J. J. (Eds.). (2008). Real-time coastal observing systems for ecosystem dynamics and harmful algal blooms: Theory, instrumentation and modelling. Paris, France: UNESCO; Boca Raton, Florida: CRC Press. 2. IOCCG (International Ocean Colour Coordinating Group). (2000). Remote sensing of ocean colour in coastal, and other optically complex waters. (IOCCG Report No. 3). Dartmouth, Nova Scotia, Canada: IOCCG. 3. Kirk, J. T. O. (2011). Light and photosynthesis in aquatic ecosystems (3rd ed.). Cambridge, United Kingdom: Cambridge University Press. 4. Lee, Z. (2021). Remote sensing of aquatic coastal ecosystem processes: Science and management applications. Cham, Switzerland: Springer. 5. Mobley, C. D. (1994). Light and water: Radiative transfer in natural waters. San Diego, California: Academic Press.			

References/ Readings:	1. Bricaud, A., Babin, M., Morel, A., & Claustre, H. (1995). Variability in the chlorophyll-specific absorption coefficients of natural phytoplankton: Analysis and parameterization. Journal of Geophysical Research, 100(C7), 13321–13332. https://doi.org/10.1029/95JC00463 2. Gordon, H. R., & Morel, A. (1983). Remote assessment of ocean colour for interpretation of satellite visible imagery: A review. Springer-Verlag Lecture Notes in Coastal and Estuarine Studies, 4, 114 pp. 3. Lee, Z., Carder, K. L., & Arnone, R. A. (2002). Deriving inherent optical properties from water color: A multiband quasi-analytical algorithm for optically deep waters. Applied Optics, 41(27), 5755–5772. https://doi.org/10.1364/AO.41.005755 4. Morel, A., & Maritorena, S. (2001). Bio-optical properties of oceanic waters: A reappraisal. Journal of Geophysical Research: Oceans, 106(C4), 7163–7180. https://doi.org/10.1029/2000JC000319 5. Sathyendranath, S., & Platt, T. (1993). Remote sensing of water-column primary production. International Journal of Remote Sensing, 14(3), 593–609. https://doi.org/10.1080/01431169308904360
Web Resources:	1. European Centre for Medium-Range Weather Forecasts (ECMWF). (n.d.). Atmospheric data including aerosol forecasts and reanalysis. https://atmosphere.copernicus.eu 2. Indian Space Research Organisation. (n.d.). Space Applications Centre: Earth observation, atmospheric studies, and remote sensing programs. https://www.sac.gov.in 3. NASA Goddard Space Flight Center. (n.d.). AERONET: Aerosol monitoring and validation network. https://aeronet.gsfc.nasa.gov 4. NASA. (n.d.). MODIS, VIIRS, and TROPOMI aerosol data access. Earth Observing System Data and Information System (EOSDIS). https://earthdata.nasa.gov 5. Space Applications Centre (ISRO). (n.d.). Satellite data for meteorology and oceanography. https://www.mosdac.gov.in

Discipline Specific Elective Courses

Title of the Course	Remote Sensing and Climate
Course Code	RSG-5204
Number of Credits	2
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course introduces the principles and techniques of remote sensing for climate system monitoring and modelling, focusing on satellite observation of key climate variables such as temperature, precipitation, aerosols, and greenhouse gases. It develops skills in interpreting climate datasets, detecting variability and trends, and understanding their relevance to global policy frameworks like the IPCC and SDGs.	
Course Outcomes:	Students will be able to,	**Mapped to PSO**
	CO 1. Understand how satellite remote sensing contributes to observing the Earth's climate system.	PSO 1, PSO 2
	CO 2. Understand the retrieval of essential climate variables (ECVs) using passive and active satellite sensors.	PSO 2

	CO 3. Use satellite-derived datasets to analyse ECV trends.		PSO 3	
	CO 4. Interpret climate variability and assess regional climate impacts and anomalies.		PSO 3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction to Climate Systems and Climate Change; Essential Climate Variables (ECVs) and Satellite-Based Climate Monitoring; Overview of Earth Observation Missions (NASA, ESA, ISRO, NOAA); Radiation Laws: Planck's Law, Stefan-Boltzmann Law, Wien's Law; Earth's Energy Balance and Radiative Transfer Principles; Atmospheric Remote Sensing and Climate Variability; Measurement of Greenhouse Gases (CO_2, CH_4, O_3) and Climate Forcing; Satellite-Based Observations of Atmospheric Temperature and Humidity; Aerosols and Their Role in Climate; Cloud Cover, Albedo, and Radiative Forcing	**15**	CO 1, CO 2	K1, K2
Module 2:	Satellite-Based Precipitation Measurements; Remote Sensing of Cyclones, Droughts, and Heatwaves; Sea Surface Temperature and Ocean Circulation (MODIS, Sentinel-3); Satellite Altimetry and Sea Level Rise Monitoring; Remote Sensing of Vegetation and Land Use Change; Monitoring Snow Cover, Glaciers, and Ice Sheets; Remote Sensing of Forest Carbon Storage; Carbon Cycle and Climate Feedbacks; Role of AI/ML in Climate Data Analysis; Climate Data Fusion: Optical, IR, and Microwave Integration; Satellite Data in Climate Policy and Mitigation Strategies;	**15**	CO 3, CO 4	K1, K2
Pedagogy:	Use of Conventional, Online and ICT Methods. Lecture/Tutorials/Assignments			
Texts:	1. Goody, R. M., & Yung, Y. L. (1995). *Atmospheric radiation: Theoretical basis* (2nd ed.). New York, New York: Oxford University Press. 2. IPCC. (2021). *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, United Kingdom: Cambridge University Press. 3. Jensen, J. R. (2007). *Remote sensing of the environment: An Earth resource perspective* (2nd ed.). Upper Saddle River, New Jersey: Pearson. 4. Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). *Remote sensing and image interpretation* (7th ed.).			

	Hoboken, New Jersey: Wiley. 5. Trewartha, G. T., & Horne, L. H. (1980). *An introduction to climate* (5th ed.). New York, New York: McGraw-Hill.
References/ Readings:	1. Hall, D. K., & Riggs, G. A. (2007). Accuracy assessment of the MODIS snow-cover products. Hydrological Processes, 21(12), 1534–1547. https://doi.org/10.1002/hyp.6715 2. Liu, Y. Y., et al. (2015). Recent reversal in loss of global terrestrial biomass. Nature Climate Change, 5(5), 470–474. https://doi.org/10.1038/nclimate2581 3. Trenberth, K. E., Fasullo, J. T., & Kiehl, J. (2009). Earth's global energy budget. Bulletin of the American Meteorological Society, 90(3), 311–324. https://doi.org/10.1175/2008BAMS2634.1 4. Wentz, F. J., & Schabel, M. (2000). Precise climate monitoring using complementary satellite data sets. Nature, 403(6768), 414–416. https://doi.org/10.1038/35000184 5. Zhang, Y., Rossow, W. B., Lacis, A. A., Oinas, V., & Mishchenko, M. I. (2004). Calculation of radiative fluxes from the surface to top of atmosphere based on ISCCP and other global data sets: Refinements of the radiative transfer model and the input data. Journal of Geophysical Research: Atmospheres, 109(D19). https://doi.org/10.1029/2003JD004457
Web Resources:	1. Copernicus Climate Data Store (CDS). (n.d.). Essential climate variables and ERA5 reanalysis datasets. https://cds.climate.copernicus.eu 2. IPCC Data Distribution Centre. (n.d.). Climate change scenarios, observations, and projections. https://www.ipcc-data.org 3. NASA Earthdata. (n.d.). Climate Data from MODIS, AIRS, CERES, and OCO-2. https://earthdata.nasa.gov

Title of the Course	Remote Sensing and Climate Practical
Course Code	RSG-5205
Number of Credits	2
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course introduces the principles and techniques of remote sensing for climate system monitoring and modelling, focusing on satellite observation of key climate variables such as temperature, precipitation, aerosols, and greenhouse gases. It develops skills in interpreting climate datasets, detecting variability and trends, and understanding their relevance to global policy frameworks like the IPCC and SDGs.	
Course Outcomes:	Students will be able to,	**Mapped to PSO**
	CO 1. Apply remote sensing tools to acquire and visualise satellite-based climate datasets.	PSO 1, PSO 2
	CO 2. Process and interpret atmospheric datasets including greenhouse gases and aerosols.	PSO 2
	CO 3. Analyze precipitation trends, SST variations, and cyclone tracks using multi-temporal datasets.	PSO 3
	CO 4. Interpret climate change case studies, structured reports and policy briefs.	PSO 3

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Familiarisation with software packages Panoply/SeaDAS/.SNAP/QGIS/ ERDAS/ArcGIS/Python/MATLAB; Accessing global and regional climate data from NASA Earthdata/ESA Climate Change Initiative (CCI)/ISRO Bhuvan/Bhoonidhi portals; Working with NetCDF/HDF formats in Panoply, QGIS, or Python; Visualising trends in global temperature, rainfall, and carbon concentrations; Greenhouse gas analysis (CO_2, CH_4) using OCO-2, TROPOMI datasets; Aerosol Optical Depth (AOD) retrieval and analysis from MODIS; Atmospheric correction techniques for optical data pre-processing.	**30**	CO1, CO2	K1, K2
Module 2:	Satellite-based precipitation data processing; Cyclone detection and tracking using satellite imagery; Estimation of storm intensity, rainfall anomaly, and landfall impact; Sea Surface Temperature (SST) mapping and anomaly trend analysis; Time-series case studies: heatwaves, floods, or ENSO signals; Interpreting remote sensing findings to assess regional climate impacts; Communication in Climate Science: visuals, summaries, and policy briefs.	**30**	CO3, CO4	K1, K2
Pedagogy:	Use of Conventional, Online and ICT Methods. Hands-on Practical			
Texts:	1. Goody, R. M., & Yung, Y. L. (1995). Atmospheric radiation: Theoretical basis (2nd ed.). New York, New York: Oxford University Press. 2. IPCC. (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom: Cambridge University Press. 3. Jensen, J. R. (2007). Remote sensing of the environment: An Earth resource perspective (2nd ed.). Upper Saddle River, New Jersey: Pearson. 4. Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). Remote sensing and image interpretation (7th ed.). Hoboken, New Jersey: Wiley. 5. Trewartha, G. T., & Horne, L. H. (1980). An introduction to climate (5th ed.). New York, New York: McGraw-Hill.			
References/	1. Hall, D. K., & Riggs, G. A. (2007). Accuracy assessment of the MODIS snow-cover products. Hydrological			

Readings:	Processes, 21(12), 1534–1547. https://doi.org/10.1002/hyp.6715 2. Liu, Y. Y., et al. (2015). Recent reversal in the loss of global terrestrial biomass. Nature Climate Change, 5(5), 470–474. https://doi.org/10.1038/nclimate2581 3. Trenberth, K. E., Fasullo, J. T., & Kiehl, J. (2009). Earth's global energy budget. Bulletin of the American Meteorological Society, 90(3), 311–324. https://doi.org/10.1175/2008BAMS2634.1 4. Wentz, F. J., & Schabel, M. (2000). Precise climate monitoring using complementary satellite data sets. Nature, 403(6768), 414–416. https://doi.org/10.1038/35000184 5. Zhang, Y., Rossow, W. B., Lacis, A. A., Oinas, V., & Mishchenko, M. I. (2004). Calculation of radiative fluxes from the surface to the top of the atmosphere based on ISCCP and other global data sets: Refinements of the radiative transfer model and the input data. Journal of Geophysical Research: Atmospheres, 109(D19). https://doi.org/10.1029/2003JD004457
Web Resources:	1. Copernicus Climate Data Store (CDS). (n.d.). Essential climate variables and ERA5 reanalysis datasets. https://cds.climate.copernicus.eu 2. IPCC Data Distribution Centre. (n.d.). Climate change scenarios, observations, and projections. https://www.ipcc-data.org 3. NASA Earthdata. (n.d.). Climate Data from MODIS, AIRS, CERES, and OCO-2. https://earthdata.nasa.gov

Title of the Course	Geospatial Application for Water Resource Management
Course Code	RSG-5206
Number of Credits	2
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course aims to provide students with an understanding of the role of remote sensing and GIS in understanding water resources and their management.	
Course Outcomes:	Students will be able to	**Mapped to PSO**
	CO 1. Explain key concepts of water resource management and watershed systems	PSO 1, PSO 2
	CO 2. Understand water interactions and quality parameters for watershed assessment.	PSO 2
	CO 3. Describe coastal hydrological systems and the impacts of sea-level rise and salinization	PSO 3
	CO 4. Assess the role of GIS models in watershed management and flood inundation mapping	PSO 3

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Introduction to Water Resource Management, Definition, importance, and challenges, Hydrological cycle and water balance, Surface water and groundwater interactions, Parameters affecting water quality, Concept of watershed, watershed delineation, Physical parameters of watershed; Submarine groundwater discharge (SGD).	**15**	CO 1, CO 2	K1, K2
Module 2:	Introduction to coastal hydrology and hydrogeology, Coastal aquifers, estuaries, and deltaic systems, impacts of sea-level rise, salinization, and tidal influences on freshwater availability, Water resource management challenges in coastal areas, GIS Models for watershed Management, Flood inundation mapping & 3D Modelling;	**15**	CO 3, CO 4	K1, K2
Pedagogy:	Use of Conventional, Online and ICT Methods. Lecture / Tutorials / Assignments			
Texts:	1. Bhaskar, N. R., & James, D. L. (1993). *Surface Water Hydrology*. Englewood Cliffs, New Jersey: Prentice Hall.. 2. Chow, V. T., Maidment, D. R., & Mays, L. W. (1988). *Applied Hydrology*. New York, New York: McGraw-Hill. 3. Goudie, A. (2013). *The Human Impact on the Natural Environment: Past, Present, and Future*. Chichester, United Kingdom: Wiley-Blackwell. 4. Grabs, W., & Martinec, J. (1991). *Hydrological Models for Water Resources System Design and Operation*. Paris, France: UNESCO. 5. Jensen, J. R. (2007). *Remote Sensing of the Environment: An Earth Resource Perspective*. Upper Saddle River, New Jersey: Pearson Education. 6. Linsley, R. K., Franzini, J. B., Freyberg, D. L., & Tchobanoglous, G. (1992). *Water Resources Engineering*. New York, New York: McGraw-Hill. 7. Maidment, D. R. (2002). *Arc Hydro: GIS for Water Resources*. Redlands, California: ESRI Press. 8. Raghunath, H. M. (2006). *Hydrology: Principles, Analysis and Design*. New Delhi, India: New Age International Publishers.			
References/ Readings:	1. Jeznach, L. C., & Granato, G. E. (2020). Comparison of SELDM simulated total-phosphorus concentrations with ecological impervious-area criteria. Journal of Environmental Engineering, 146(8), 04020077. https://doi.org/10.1061/(ASCE)EE.1943-7870.0001763 2. Nagahama, V. H., Sweeney, J., & Cahill, N. (2024). A scalable Bayesian spatiotemporal model for water level			

	predictions using a nearest neighbour Gaussian process approach. arXiv preprint arXiv:2412.06934. https://arxiv.org/abs/2412.06934 3. Rawat, S., Tateh, S., & Dubey, S. (2025). Geographical information system (GIS) applications for water resources management. *International Journal of Advanced Research in Science, Communication and Technology*, 7(1), 613–620. 4. Stonewall, A. J., Granato, G. E., & Glover-Cutter, K. M. (2019). Assessing potential effects of highway and urban runoff on receiving streams in total maximum daily load watersheds in Oregon using the Stochastic Empirical Loading and Dilution Model. U.S. Geological Survey Scientific Investigations Report 2019–5053. https://doi.org/10.3133/sir20195053 5. Weaver, J. C., Granato, G. E., & Fitzgerald, S. A. (2019). Assessing water quality from highway runoff at selected sites in North Carolina with the Stochastic Empirical Loading and Dilution Model (SELDM). U.S. Geological Survey Scientific Investigations Report 2019–5031. https://doi.org/10.3133/sir20195031
Web Resources:	1. HydroSHEDS – Hydrological Data and Mapping https://www.hydrosheds.org/ 2. India-WRIS (Water Resources Information System of India) https://indiawris.gov.in/ 3. International Water Management Institute (IWMI). https://www.iwmi.cgiar.org/ 4. National Water Informatics Centre (NWIC), India https://nwic.gov.in/ 5. World Bank – Water Resource Management. https://www.worldbank.org/en/topic/waterresourcesmanagement

Title of the Course	Geospatial Application for Water Resource Management Practical
Course Code	RSG-5207
Number of Credits	2
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value-added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course aims to provide students with hands-on experience in using remote sensing and GIS techniques in water resource management.	
Course Outcomes:	Students will be able to,	**Mapped to PSO**
	CO 1. Apply spectral indices and change detection techniques for mapping surface water bodies	PSO 1, PSO 2
	CO 2. Analyze spatial patterns of water quality parameters using GIS tools.	PSO 2
	CO 3. Analyze watershed and drainage for spatial analysis and assessment.	PSO 3
	CO 4. Simulate flood inundation and hydrologic processes using 3D and GIS-based models	PSO 3

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Familiarisation with software packages Panoply/SeaDAS/.SNAP/QGIS/ ERDAS/ArcGIS/Python/MATLAB; Mapping surface water bodies using Spectral Indices, Change detection of lakes, wetlands, and estuaries; Turbidity mapping; Visualization of water quality data in GIS (pH, EC, TDS, salinity)	30	CO 1, CO 2	K1, K2, K3
Module 2:	Watershed and drainage extraction using Digital Elevation Models; Morphometric Analysis (stream ordering, Stream length, Drainage density, Basin relief, Slope analysis); Flood inundation mapping and simulation & 3D Modelling, hydrologic simulation modelling;	30	CO 3, CO 4	K2, K3
Pedagogy:	Use of Conventional, Online and ICT Methods. Hands-on Practical			
Texts:	1. Bhaskar, N. R., & James, D. L. (1993). Surface Water Hydrology. Englewood Cliffs, New Jersey: Prentice Hall.. 2. Chow, V. T., Maidment, D. R., & Mays, L. W. (1988). Applied Hydrology. New York, New York: McGraw-Hill. 3. Goudie, A. (2013). The Human Impact on the Natural Environment: Past, Present, and Future. Chichester, United Kingdom: Wiley-Blackwell. 4. Grabs, W., & Martinec, J. (1991). Hydrological Models for Water Resources System Design and Operation. Paris, France: UNESCO. 5. Jensen, J. R. (2007). Remote Sensing of the Environment: An Earth Resource Perspective. Upper Saddle River, New Jersey: Pearson Education. 6. Linsley, R. K., Franzini, J. B., Freyberg, D. L., & Tchobanoglous, G. (1992). Water Resources Engineering. New York, New York: McGraw-Hill. 7. Maidment, D. R. (2002). Arc Hydro: GIS for Water Resources. Redlands, California: ESRI Press. 8. Raghunath, H. M. (2006). Hydrology: Principles, Analysis and Design. New Delhi, India: New Age International Publishers.			
References/ Readings:	1. Jeznach, L. C., & Granato, G. E. (2020). Comparison of SELDM simulated total-phosphorus concentrations with ecological impervious-area criteria. Journal of Environmental Engineering, 146(8), 04020077. https://doi.org/10.1061/(ASCE)EE.1943-7870.0001763 2. Nagahama, V. H., Sweeney, J., & Cahill, N. (2024). A scalable Bayesian spatiotemporal model for water level			

	predictions using a nearest neighbour Gaussian process approach. arXiv preprint arXiv:2412.06934. https://arxiv.org/abs/2412.06934 3. Rawat, S., Tateh, S., & Dubey, S. (2025). Geographical information system (GIS) applications for water resources management. *International Journal of Advanced Research in Science, Communication and Technology*, 7(1), 613–620. 4. Stonewall, A. J., Granato, G. E., & Glover-Cutter, K. M. (2019). Assessing potential effects of highway and urban runoff on receiving streams in total maximum daily load watersheds in Oregon using the Stochastic Empirical Loading and Dilution Model. U.S. Geological Survey Scientific Investigations Report 2019–5053. https://doi.org/10.3133/sir20195053 5. Weaver, J. C., Granato, G. E., & Fitzgerald, S. A. (2019). Assessing water quality from highway runoff at selected sites in North Carolina with the Stochastic Empirical Loading and Dilution Model (SELDM). U.S. Geological Survey Scientific Investigations Report 2019–5031. https://doi.org/10.3133/sir20195031
Web Resources:	1. HydroSHEDS – Hydrological Data and Mapping https://www.hydrosheds.org/ 2. India-WRIS (Water Resources Information System of India) https://indiawris.gov.in/ 3. International Water Management Institute (IWMI). https://www.iwmi.cgiar.org/ 4. National Water Informatics Centre (NWIC), India https://nwic.gov.in/ 5. World Bank – Water Resource Management. https://www.worldbank.org/en/topic/waterresourcesmanagement