



ADAMAS UNIVERSITY

SCHOOL OF BASIC AND APPLIED SCIENCES

DEPARTMENT OF GEOGRAPHY

Program Name:

M.Sc. (GEOINFORMATICS)

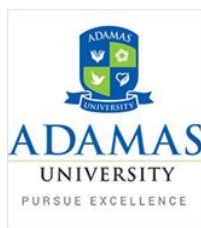
BATCH 2025-26

Program Code:

Total Credit: 95

Syllabus

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



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

VISION OF THE UNIVERSITY

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

MISSION STATEMENTS OF THE UNIVERSITY

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

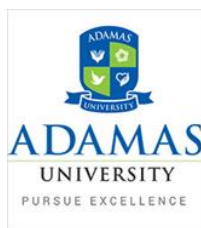
M.S 02: Foster outcomes based education system for continuous improvement in education, research and all allied activities

M.S 03: Instill the notion of lifelong learning through culture of research and innovation

M.S 04: Collaborate with industries, research centers and professional bodies to stay relevant and up-to-date

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

CHANCELLOR / VICE CHANCELLOR



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

VISION OF THE SCHOOL

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

MISSION STATEMENTS OF THE SCHOOL

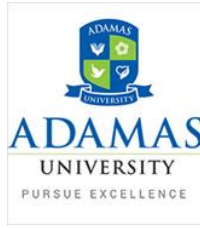
M.S 01: Develop solutions for the challenges in sciences through value-based science education.

M.S 02: Conduct research leading to innovation in sciences.

M.S 03: Nurture students into scientifically competent professionals in the usage of modern tools.

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

DEAN (SoBAS)



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

VISION OF THE DEPARTMENT

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

MISSION STATEMENTS OF THE DEPARTMENT

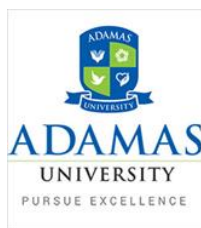
M.S 01: Create highly qualified and employable geographers by imparting quality education and research aptitude

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

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

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

HOD, Geography/ DEAN (SoBAS)



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

NAME OF THE PROGRAMME: M.SC IN GEOINFORMATICS

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

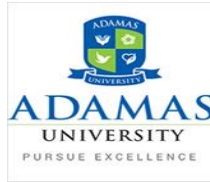
PEO 01: Break down existing environmental problems into achievable sustainable solution.

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

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

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

HOD, Geography/ DEAN (SoBAS)



**ADAMAS UNIVERSITY, KOLKATA
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DEPARTMENT OF GEOGRAPHY**

GRADUATE ATTRIBUTE / PROGRAMME OUTCOME (PO)

GA 01 / PO 01: Advanced Knowledge in Geoinformatics: Identify and explain principles, concepts, methods, and techniques relevant to geoinformation processing and earth observation for research and societal benefits.

GA 02 / PO 02: Specialized Knowledge for Future Research: Use and design models to simulate processes in the system earth with a spatial component and in-depth knowledge and research capabilities in, at least one particular applied field of geoinformatics.

GA 03 / PO 03: Analyse problems from a geospatial perspective: Analyse scientific and practical domain problems systematically and develop scientifically valid solutions for these problems in a societal context.

GA 04 / PO 04: Modern Research Skills for Spatial Data Analysis: Independently design and carry out research in the domain according to scientific quality standards. Manipulate, visualize and analyze maps and spatial data for a variety of purposes through geo-computation, digital cartography, programming, remote sensing and GIS techniques.

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

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

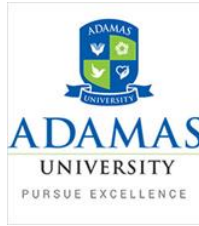
GA 07 / PO 07: Development of Communication Skill and Leaderships: Communicate both orally and in writing on findings of research work to specialists and non-specialists and develop quality for leadership, work in a group, and other extracurricular activities.

GA 08 / PO 08: Professional Development: Capable to compete in various competitive examinations for research (NET/SLET) and government jobs, and efficient to make a career as research project scientists and GIS Analysts.

GA 09 / PO 09: Ethics: Operate professionally and ethically in a multi-cultural environment and critically reflect on own and other's work.

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

HOD, Geography/ DEAN (SoBAS)



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

PROGRAMME SPECIFIC OUTCOME (PSO)

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

PSO 02: Specialized Knowledge and Research: Specialized knowledge in the applied fields of geoinformatics and capabilities to design and carry out research in the domain of geospatial science

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

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

HOD, Geography/ DEAN (SoBAS)

Program Structure for 2-year Postgraduate Programs with Exit Option

1st Year of PG curricular structure for 2-year PG Programmes (3+2)

| 1 st Year | | | | | | | | |
|-------------------------|---------------------------|------------------|---|------------------------|---|---|-----------|--------------|
| SEMESTER I | | | | | | | | |
| Sl. No. | Type of Course | Code | Title of the Course | Contact Hours Per Week | | | | Total Credit |
| | | | | L | T | P | C | |
| 1 | CC | GEO475 | Geoinformatics I | 2 | 0 | 3 | 4 | |
| 2 | CC | GEO476 | Digital Image Processing | 2 | 0 | 3 | 4 | |
| 3 | CC | GEO477 | Advanced Cartography and Surveying | 2 | 0 | 3 | 4 | |
| 4 | DSE/ MDE | GEO478 GEO479 | <p>Discipline Specific Elective courses-</p> <p>1. Open-Source GIS Lab 2. Computer Fundamentals</p> <p>SAWYAM MOOC courses</p> <p>(Any courses aligning with the themes of specified DSE courses, subject to availability in the portal within the stipulated time frame)</p> | 0 | 0 | 6 | 4 | |
| 5 | RM | GEO480 | Research Methodology | 1 | 0 | 2 | 2 | |
| 6 | SEC 1 (Hands-On Training) | CSE486 | Basic Programming | 0 | 0 | 3 | 2 | |
| 7 | SEC 2 | ENG445 | Business Communication Basic | 2 | 0 | 0 | 2 | |
| 8 | SEC 3 | CLL406 | Career Development Course I (Soft Skill / Soft Skill and Aptitude Course) | 1 | 0 | 0 | 1 | |
| 9 | AEC | AEC408/9/10 | Foreign Language | 2 | 0 | 0 | 2 | |
| Semester Credits | | | | | | | 25 | |
| SEMESTER II | | | | | | | | |
| 1 | CC | GEO481 | Geoinformatics II | 2 | 0 | 3 | 4 | |
| 2 | CC | GEO482 | Advanced Photogrammetry | 2 | 0 | 3 | 4 | |
| 3 | DSE | GEO483 GEO484 | <p>Discipline Specific Elective courses-</p> <p>1. Geostatistics 2. Geo-spatial Analysis and its Applications Lab</p> <p>SAWYAM MOOC courses</p> <p>(Any courses aligning with the themes of specified DSE courses,</p> | 0 | 0 | 6 | 4 | |

| | | | | | | | | |
|--|---------------------------|------------------|---|---|---|---|-----------|--|
| | | | subject to availability in the portal within the stipulated time frame) | | | | | |
| 4 | MDE | CSE585 GEO485 | MDE Pool: 1. Database Management Systems 2. Computer-Aided Design & BIM SAWYAM MOOC courses (Any courses aligning with the themes of specified MDE courses, subject to availability in the portal within the stipulated time frame) | 0 | 0 | 6 | 4 | |
| 5 | Project | GEO486 | Dissertation I | 0 | 0 | 3 | 2 | |
| 6 | AEC | AEC503/4/5 | Foreign Language | 2 | 0 | 0 | 2 | |
| 7 | SEC 1 (Hands-On Training) | CSE586 | Python for Geospatial Analysis | 0 | 0 | 3 | 2 | |
| 8 | SEC 2 | ENG446 | Business Communication Intermediate | 2 | 0 | 0 | 2 | |
| 9 | SEC 3 | CLL407 | Career Development Course I (Soft Skill / Soft Skill and Aptitude Course) | 1 | 0 | 0 | 1 | |
| Semester Credits | | | | | | | 25 | |
| Exit option with Post-Graduate Diploma after the first year or two semesters, with the completion of courses equivalent to 50 credits | | | | | | | | |

2nd Year of PG curricular structure for 2-year PG Programmes

One-year PG Programme after completion of a Four-Year UG Programme (4+1)

PG Curricular Structure with Coursework and Research

| 2nd Year | | | | | | | | |
|----------------------------|------------------------------|------------------|--|-------------------------------|----------|----------|-----------|----------------|
| SEMESTER III | | | | | | | | |
| Sr. No | Type of Course | Code | Title of the Course | Contact Hours Per Week | | | | Remarks |
| | | | | L | T | P | C | |
| 1 | CC | GEO550 | Geoinformatics III | 2 | 0 | 3 | 4 | |
| 2 | CC | GEO551 | Advanced Computation using Geo-AI | 2 | 0 | 3 | 4 | |
| 3 | CC | GEO552 | Cloud Computation for Spatial Data Analysis | 0 | 0 | 6 | 4 | |
| 4 | DSE | GEO554 GEO555 | Bucket List: 1. Spatial Data Science with R 2. Web and Mobile GIS | 0 | 0 | 6 | 4 | |
| 5 | Project | GEO556 | Dissertation II | 0 | 0 | 3 | 2 | |
| 6 | ED | GEO553 | Startup Skill Development | 2 | 0 | 0 | 2 | |
| 7 | SEC 1 (Hands-On Training) | CSE587 | JavaScript for Geospatial Applications | 0 | 0 | 3 | 2 | |
| 8 | SEC 2 | ENG447 | Business Communication Advanced | 2 | 0 | 0 | 2 | |
| 9 | SEC 3 | CLL503 | Career Development Course I (Soft Skill / Soft Skill and Aptitude Course) | 1 | 0 | 0 | 1 | |
| Semester Credits | | | | | | | 25 | |
| SEMESTER IV | | | | | | | | |
| 1 | INT | GEO557 | Internship | 0 | 0 | 12 | 08 | |
| 2 | Project | GEO558 | Dissertation III | 0 | 0 | 12 | 08 | |
| 3 | Project | GEO559 | Field Project | 0 | 0 | 6 | 04 | |
| | | | | | | | 20 | |
| Total Credits | | | | | | | 45 | |

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

SEMESTER I

| | | | | | |
|--------------------------------|---|----------|----------|----------|----------|
| GEO475 | Geoinformatics I | L | T | P | C |
| Version 1.1 | Contact Hours – 75 | 2 | 0 | 3 | 4 |
| Pre-requisites/Exposure | Undergraduate level Geography knowledge | | | | |
| Co-requisites | | | | | |

Course Outcomes

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

CO1: Recall the fundamental concepts of remote sensing, GIS, GPS, and GNSS.

CO2: Interpret different spatial and non-spatial data.

CO3: Apply different image processing and GIS techniques.

CO4: Categorize different platforms, sensors, and segments of GNSS.

CO5: Evaluate different methods of georeferencing and visual data interpretation.

CO6: Create different corrected spatial data.

Course Content

Unit 1: Fundamentals of Remote Sensing (17 hours)

Introduction to Remote Sensing, Remote sensing process: Physics of Remote Sensing: Electro Magnetic Radiation, EMR Theory, Energy sources, and Radiation principles: Energy interaction in the atmosphere: Energy interaction with earth surface features: Spectral reflectance of earth surface feature types; Types of Remote Sensing System – Characteristics of Optical, Thermal and Microwave, and Hyperspectral; Platforms, Orbits, Sensors, Concept of Resolution: Spatial, Spectral, Radiometric, and Temporal; Characteristic of Multispectral Earth Observation satellites; IRS, Landsat, Sentinel.

Lab Exercises: Spectral Bands, Band Combinations – True and False Colour Composites; Resolution of IRS, Landsat, and Sentinel 2 images.

Unit II: Introduction to Digital Image Processing (20 hours)

Color image fundamentals – RGB, HSI models; Mosaicing, and Subsetting of Digital Images, Georeferencing – Single Image and Image-to-Image Georeferencing; Reproject; Elements of Visual Image Interpretation – Visual Data interpretation keys.

Lab Exercises: Layer Stacking; Mosaicing and Subsetting of Digital Images; Colour Transformation – RGB and IHS; Georeferencing – Single Image and Image-to-Image Georeferencing; Reprojection; Visual Image Interpretation using False Colour Composites, Identification of Physical and Cultural Features from False Colour Composites.

Unit III: Introduction to Geographic Information System (20 hours)

Components of GIS; GIS data formats; Vector data structure – Spatial and non-spatial data; Concept of geodatabase; Coordinate systems and spatial reference. Digital Cartography and Thematic mapping: map composition and representation.

Lab Exercises: Creation of vector database: point, line, and polygon, geopackage creation and attribute joining; measurement tools, changing projection, Thematic mapping: map composition and representation.

Unit IV: Introduction to GNSS and GPS (18 hours)

Introduction to earth's positioning system; Types and segments of global navigation satellite systems: GPS, GALILEO, GLONASS and GAGAN; Applications of GNSS

Lab Exercises: Principles of Global Positioning System (GPS); Collection of GPS data and mapping, Introduction to Geoportal Applications – Google Earth.

Laboratory Notebook and Viva Voce

Recommended Readings:

1. Bhatta B., 2021: Remote Sensing and GIS, Oxford Publisher.
2. Campbell J. B., 2011: Introduction to Remote Sensing, Guildford Press.
3. Jensen J. R., 2017: Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall.
4. Joseph, G. and Jeganathan, C., 2020: Fundamentals of Remote Sensing, United Press India.
5. Lillesand T. M., Kiefer R. W. and Chipman J. W., 2022: Remote Sensing and Image Interpretation, Wiley. (Wiley Indian Edition).
6. Fazal, S. 2008: GIS Basics, New Age International (P) Limited, Publishers, New Delhi
7. Harvey, F. 2008: A Primer of GIS: Fundamental Geographic and Cartographic Concepts, The Guilford Press, New York
8. Reddy, M.A. 2008. Remote Sensing and Geographical Information Systems, B S Publication, Hyderabad.
9. Sahu, K.C. 2007: Textbook of Remote Sensing and Geographical Information Systems, Atlantic Publishers, New Delhi.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|---|---|---|---|---|
| GEO476 | Digital Image Processing | L | T | P | C |
| Version 1.0 | Contact Hours – 75 | 2 | 0 | 3 | 4 |
| Pre-requisites/Exposure | Undergraduate-level knowledge of GIS and RS | | | | |
| Co-requisites | Basic knowledge of computer skills | | | | |

Course Outcomes

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

CO1: Define the different image processing techniques.

CO2: Compare between different image enhancement and classification methods.

CO3: Identify the advanced image processing concepts including image segmentation, fusion, etc.

CO4: Examine the effects of image preprocessing and enhancement techniques.

CO5: Appraise different classification, fusion, and change detection methods.

CO6: Construct enhanced images and classified thematic maps with desired accuracy.

Course Content

Unit I: Image Preprocessing (18 Hours)

Digital Image Data Formats – BIP, BIL, BSQ, Run-length Encoding; Types and Sources of Errors: Atmospheric, Radiometric, and Geometric – Image Rectification: Geometric Correction, Radiometric Correction – Atmospheric Correction, Relative, and Absolute Radiometric Correction; Noise Removal; RMS Error.

Lab Exercises: Geometric and Radiometric Corrections – Image to Image and Single Image Rectification; Haze and Noise Corrections; Sun Angle and Atmospheric Correction; Absolute and Relative Corrections.

Unit II: Image Enhancement (20 Hours)

Contrast Manipulation – Gray level thresholding, level slicing, linear and non-linear contrast enhancement; Histogram processing – histogram matching and histogram equalization; Spatial and Frequency Domain – Spatial Filtering – Spatial Convolution Filtering – High Pass and Low Pass Filtering – Statistical filters – Minimum, Maximum, Median, Mean, Olympic – Edge Enhancement and Edge Detection Filters – Non-Linear Edge Enhancement Filters – Laplacian, Sobel, Roberts, Kirsch; Filtering in Frequency Domain – Fourier Transform – Band Ratioing, Spectral Indices, Principal Component Analysis. Kauth-Thomas Transformation.

Lab Exercises: Histogram Matching; Histogram Equalization; Spatial Filtering – Spatial Convolution Filtering – High Pass and Low Pass Filtering; Edge Enhancement and Edge Detection Filters – Non-Linear Edge Enhancement Filters; Band Ratioing, Spectral Indices, Principal Component Analysis. Kauth-Thomas Transformation.

Unit III: Digital Image Classification (20 Hours)

Unsupervised Classification – Chain Method, ISODATA, K-Means – Training Sites Selection and Statistical Information Extraction; Supervised Classifier – Minimum Distance to Means, Parallelepiped, Maximum Likelihood – Hybrid Classifiers – Classification Accuracy Assessment and Error Matrix GCP and ground validation of data/image.

Lab Exercises: Unsupervised Classification – ISODATA, K-Means – Training Sites Selection and Statistical Information Extraction; Supervised Classifier – Minimum Distance to Means, Parallelepiped, Maximum Likelihood – Hybrid Classifiers – Classification Accuracy Assessment and Error Matrix GCP and ground validation of data/image

Unit IV: Advanced Digital Image Processing (17 Hours)

Object-based Classification; Image Segmentation – Types, Advantages, and Applications; Image Fusion – Multi-Temporal and Multi-Sensor Image Fusion – Digital Change Detection – Remote Sensing System Change Detection Considerations.

Lab Exercises: Object-based Classification; Image Segmentation; Image Fusion – Multi-Temporal and Multi-Sensor Image Fusion – Digital Change Detection.

Laboratory Notebook and Viva Voce

Text Book:

1. Rafael C. Gonzalez & Richard E. Woods – Digital Image Processing – Pearson Education-2/e – 2004.
2. Bhatta B., 2011: Remote Sensing and GIS, Oxford Publisher.
3. Anil. K. Jain – Fundamentals of Digital Image Processing- Pearson Education-2003.

Recommended Readings:

1. Campbell J. B., 2011: Introduction to Remote Sensing, Guildford Press.
2. Cha, B., Dattaa, D., Majumdar (2001): Digital Image Processing Analysis, Prentice-Hall of India, New Delhi
3. Jensen J. R., 2017: Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall.
4. Joseph, G. and Jeganathan, C., 2020: Fundamentals of Remote Sensing, United Press India.
5. Lillesand, T. M., Kiefer, R. W. Chipman, J. W. 2022: Remote Sensing and Image Interpretation, John Wiley & Sons, New Delhi
6. Malay K. Pakhira, “Digital Image Processing and Pattern Recognition”, First Edition, PHI Learning Pvt. Ltd., 2011.
7. Nag, P. Kudrat, M., 1998: Digital Remote Sensing, Concept Publishing Company, New Delhi
8. Rees W. G., 2001: Physical Principles of Remote Sensing, Cambridge University Press.
9. Richards, J. A, Jia,X., 1999: Remote Sensing and Digital Image Processing, Springer, Verlag Berlin
10. Sabins, F. F., and James M. Ellis 2020: Remote Sensing: Principles an Interpretation, W. H. Freeman Company, New York

11. Singh R. B. and Murai S., 1998: Space-informatics for Sustainable Development, Oxford and IBH Pub.
12. Willliam K Pratt, "Digital Image Processing", John Willey, 2002.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|---|---|---|---|---|
| GEO477 | Advanced Cartography and Surveying | L | T | P | C |
| Version 1.0 | Contact Hours – 75 | 2 | 0 | 3 | 4 |
| Pre-requisites/Exposure | UG level Cartography, Surveying knowledge | | | | |
| Co-requisites | - | | | | |

Course Outcomes

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

CO1: Recall the basics of cartography, map projection, and surveying.

CO2: Explain the methods of basic and modern surveying techniques.

CO3: Identify the applications of map projection and surveying techniques.

CO4: Classify different map projection and surveying techniques.

CO5: Appraise the utility of map projection, basic, and modern surveying tools including GPS, DGPS, and Total Station.

CO6: Create various spatial outputs using different map projections and surveying instruments.

Course Content

Unit I: Basics of Map Projection (20 hours)

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

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

Lab Exercises: Construction of Graticules and representation of maps using the following projections:

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

Unit II: Basic Surveying (20 Hours)

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

Lab Exercises: Measurement and Preparation of Field Books and Plans using the following instruments -

- A. Prismatic Compass,

- B. Dumpy Level
- C. Preparing ground plan and determining height and distance of an object using Transit Theodolite

Unit III: Modern Surveying Solutions (15 Hours)

Surveying methods and mathematical implication of Total station, (Triangulation and Traversing method) surveying.

Lab Exercises: Total Station Survey in field, downloading, processing and generation of survey plots using software.

Unit IV: GPS and DGPS Surveying (20 Hours)

Global Positioning System (GPS) survey: Basic principles and evolution; DGPS Survey - Components, types, and its accessories.

Lab Exercises: ; Handheld GPS Operation - feature collection, data transfer, area calculation, data processing and generation of survey plots; DGPS Surveying - surveying and data capture, Error Corrections, Integration with GIS.

Laboratory Notebook and Viva Voce

Recommended Readings:

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

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|---|----------|----------|----------|----------|
| GEO478 | Open Source GIS Lab | L | T | P | C |
| Version 1.0 | Contact Hours – 90 | 0 | 0 | 6 | 4 |
| Pre-requisites/Exposure | Undergraduate level Geography / Science / Engineering education | | | | |
| Co-requisites | Conversant with internet and computer applications. | | | | |

Course Outcomes

CO1: Recall the fundamental concepts of Open Source GIS and Database Management Systems.

CO2: Demonstrate the various functions available in QGIS, Saga GIS, PostGIS, and PostgreSQL.

CO3: Apply different Open Source GIS and Database Management Systems in geospatial applications.

CO4: Distinguish between the functions available in Open Source GIS and commercial GIS software packages.

CO5: Evaluate the significance of OpenStreet Map, Google Earth, and ISRO's Geoportal.

CO6: Create various spatial outputs using different Open Source GIS software packages.

Course Content

Unit I: Open Source GIS: QGIS (20 Hours)

Basic concepts of open source GIS, evolution of free and open source GIS, standard and protocol of open source GIS, Open Geospatial Consortium, introduction to QGIS, Georeferencing, vector creation, attribute joining and editing, vector and raster based Geoprocessing using QGIS, plugin and external software support with QGIS, layout preparation and map composition,

Unit II: Open Source GIS: Saga GIS (20 Hours)

Introduction to Saga GIS, FCC creation, image subsetting, image enhancement, data compression-PCA, image indices, image classification (unsupervised & supervised), accuracy assessment, change detection, layout creation.

Unit III: Open Source Database Management System (30 Hours)

Fundamental of Post GIS, relationship in between PostGIS and PostgreSQL, installation of PostGIS, creating a spatial database, loading spatial data, simple SQL, geometries, geometry construction functions, advanced geometry construction, spatial relationships, spatial joining, spatial joining based problem solving, spatial indexing and associated problem solving, validity, equality, linear referencing with PostGIS, nearest neighbour searching.

Unit IV: Geoportal Applications (20 Hours)

Geoportal Applications –Openstreet Map and ISRO Bhuvan Collection and retrieval of GNSS positions, preparation of maps from GNSS data, GNSS data; Introduction to, Identification of

Spatiotemporal Change and elevation profiling from Google Earth, Working with ISRO Bhuvan Geoportal – Data extraction, vector overlay and data import.

Laboratory Notebook and Viva Voce

Recommended Readings:

1. Scott Madry., 2021: Introduction to QGIS, Locate press.
2. Hans van der Kwast, Kurt Menke., 2019: QGIS for Hydrological applications, Locate press.
3. Jensen J. R., 2017: Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall.
4. Joseph, G. and Jeganthan, C. 2020: Fundamentals of Remote Sensing, United Press India.
5. Lillesand T. M., Kiefer R. W. and Chipman J. W., 2022: Remote Sensing and Image Interpretation, Wiley. (Wiley Student Edition).
6. Olaya, V. 2004: A Gentle Introduction to SAGA GIS, can be access from <http://www.saga-gis.org/en/index.html>
7. Leo S. Hsu, Regina O. Obe, Leo Hsu ., 2011: PostGIS in Action, Manning Publications
8. Thomas J. Kraft, Stephen Vincent Mather, Paolo Corti., 2014: PostGIS Cookbook, Packt publications.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|---|----------|----------|----------|----------|
| GEO479 | Computer Fundamentals | L | T | P | C |
| Version 1.0 | Contact Hours – 90 | 0 | 0 | 6 | 4 |
| Pre-requisites/Exposure | Basic knowledge and operating capability of computers | | | | |
| Co-requisites | - | | | | |

Course Outcomes

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

- CO1. **Demonstrate** fundamental concepts about computer software and hardware.
- CO2. **Determine** the functions of Information Technology.
- CO3. **Apply** knowledgebase for data analysis using Microsoft Excel.
- CO4. **Prepare** business presentations using Microsoft Power Point.

Course Content

Unit I: Basics of Computers (20 hours)

Introduction to computers, history of development of computers, hardware and software; Fundamentals of computer system: operating systems, input devices, output devices, storage devices-primary, secondary, central processing unit, computer languages, translators.

Unit II: Information Technology (30 hours)

Introduction to information technology: the difference between information and data; common sources of Geoinformatics information; introduction to internet. Scope of internet, equipment required for an internet connection, electronic mail. Concepts of information storehouse; surfing the net: browsing the www. Search engines and their applications; application of internet to Geoinformatics; introduction to networks, local area network devices, topologies, protocols, wide area networks, servers, hubs, nodes, modems, internet, basic & advanced html, types of tags, document creations, linking, creating link list, handling images, tables and, style sheets.

Unit III: Microsoft Excel (20 hours)

Functions of Microsoft Excel: Excel work environment, changing the size of a workbook and excel window, cell and cell address, standard toolbar, the formatting toolbar, the formula bar, components of an excel workbook, moving data, copying data, relative cell addressing, absolute cell addressing; formulas using numbers; simple graphs; functions and applications of Microsoft Excel to Geoinformatics.

Unit IV: Microsoft Power point (20 hours)

Introduction to Microsoft Power Point: functions and exploring Power Point views; creating a presentation; delivering and printing a presentation; animations and slide show applications to Geoinformatics.

Recommended Readings:

1. Beekman, G. 1999, Computer Confluence: Exploring Tomorrow's Technology. Addison- Wesley, Reading, MA. (3rd. ed).
2. Willis H. Means 19087A content analysis of six introduction to computer science textbooks
3. ACM New York, NY, USA, 403 - 413
4. Beekman, G. George Beckman 2000 Tech Nation. Online. Internet. [March 14,]. Available www: [http:// www.computerconfluence.com/about/tech.htm](http://www.computerconfluence.com/about/tech.htm)
5. Cheryl SchmidtComplete 19908, Computer Repair Textbook, Scott Jones, 22-408.
6. Dix, A., Finlay, J., Abowd, G., and Beale, R. 1999. Human-Computer Interaction. Prentice-Hall, Herts. UK. 67-089.
7. Goldberg, M. W. CALOS: Feb, 1997), First Results from an Experiment in Computer-Aided
8. Learning for Operating Systems, in Proceedings of the Twentyeighth SIGCSE Technical Symposium on Computer Science Education. ACM Press. 408-52.
9. Goldberg, M. W. WebCT and First Year Computer Science June, 1997: Student Reaction to and Use of a Web-Based Resource in First Year Computer Science, in Proceedings of the ACM's ITiCSE Conference on Integrating Technology into Computer Science Education. ACM Press. 127-129.
10. Shelly Cashman 2000, Course Technology. About Shelly Cashman Series. Online. Internet. [March 14,]. Available WWW: Http://www.scseries.com/about_sc.cf

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

| | | | | | |
|--------------------------------|----------------------------------|----------|----------|----------|----------|
| GEO480 | Research Methodology | L | T | P | C |
| Version 1.1 | Contact Hours – 45 | 1 | 0 | 2 | 2 |
| Pre-requisites/Exposure | UG Level knowledge of statistics | | | | |
| Co-requisites | | | | | |

Course Outcomes

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

CO1: Recall the fundamental concepts of research objectives, process, hypothesis.

CO2: Compare different research types and data collection methods.

CO3: Organize literature review and samples.

CO4: Classify different sampling types and citation methods.

CO5: Evaluate research problems.

CO6: Construct questionnaire, research proposal, and literature review-based scientific research papers.

Course Content

Unit I: Fundamentals of Research (10 Hours)

Meaning of Research, Nature, and objectives of the research; Research Types: descriptive-analytical, pure-applied, conceptual-empirical, qualitative-quantitative; Motivations in Research; Writing corporate and scientific research reports

Unit II: Research Process (10 Hours)

Identification of research gap; Selection of research objectives; Literature Review: Conducting literature survey- searching literature, reviewing selected literature, developing theoretical and conceptual frameworks, Reporting literature review; Citation methods

Unit III: Data Collection Methods (15 Hours) (Practical)

Preparation of questionnaire, Interview: Focus group, participant observation; Hypothesis/Research Question; Sampling- Concept and principles; Probability and Non-Probability sampling- types and criteria for selection; Sample size calculation and developing sampling Frames

Unit IV: Reading and Writing a Scientific Research Paper (10 Hours) (Practical)

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

Recommended Readings:

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

3. Kerlinger, Foundation of Research.
4. Fundamentals of modern statistical methods by Rand R. Wilcox.
5. Power Analysis for Experimental Research A Practical Guide for the Biological, Medical and Social Sciences by R. Barker Bausell, Yi-Fang Li Cambridge University Press.
6. Design of Experience: Statistical Principles of Research Design and Analysis, by Robert O. Kuehl Brooks/cole.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

| Cos | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|--------------|--------------|--------------|
| CO 1 | 1 | 1 | 2 | 3 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 1 |
| CO 2 | 0 | 1 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 2 |
| CO 3 | 1 | 2 | 2 | 1 | 2 | 2 | 0 | 1 | 2 | 0 | 2 | 1 | 1 | 1 |
| CO 4 | 1 | 1 | 1 | 3 | 2 | 3 | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 1 |
| CO 5 | 0 | 1 | 0 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 0 | 2 |
| CO 6 | 1 | 1 | 2 | 3 | 2 | 3 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 1 |

| | | | | | |
|--------------------------------|---|---|---|---|---|
| CSE486 | Basic Programming | L | T | P | C |
| Version 1.0 | Contact Hours – 45 | 0 | 0 | 3 | 2 |
| Pre-requisites/Exposure | Basic knowledge and operating capability of computers | | | | |
| Co-requisites | - | | | | |

Course Outcomes

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

CO1: Recall the fundamental concepts of computer programming.

CO2: Illustrate the various functions of Python.

CO3: Apply the various condition statements in Python.

CO4: Examine the utility of condition statements and data structure.

CO5: Appraise the significance of Python coding in the context of Geoinformatics.

CO6: Develop codes using Python on condition statements and data structures.

Course Content

Unit I: Introduction to python (10 hours)

History and features of python, installing python and setting up the environment, introduction to python IDEs (Pycharm, Vscod, Jupyter notebook etc). Understanding python syntax and indentation. Basic operations: Arithmetic, comparison, logical. Declaring and initializing variables. Basic data types: integer, float, string, Boolean. Type conversion and casting. Input and output functions.

Unit II: Control structures and functions (10 hours)

Control structures: conditional statements: if, elif, else. Loops: for, while. Loop control statements: break, continue, pass. Functions: Defining and calling functions, function arguments and return values, lambda functions. Modules and packages: importing modules, introduction standard libraries.

Unit III: Python Data Structures (15 hours)

Lists: creating and accessing list elements, list operations (slicing, appending, inserting, removing), list comprehensions. Tuples: creating and accessing tuple elements. Basic tuple operations. Dictionaries: concept of key value pair, Dictionary methods: Adding, removing, updating items. Sets: union, intersection, difference.

Unit IV: String Handling (10 hours)

String: Creating and manipulating strings, string methods ('split()', 'join()', 'replace()', 'find()' etc), String formatting.

Recommended Readings:

1. Beekman, G. 1999, Computer Confluence: Exploring Tomorrow's Technology. Addison-Wesley, Reading, MA. (3rd. ed).

2. Willis H. Means 19087A content analysis of six introduction to computer science textbooks
3. ACM New York, NY, USA, 403 - 413
4. Beekman, G. George Beckman 2000 Tech Nation. Online. Internet. [March 14,]. Available www: [http:// www.computerconfluence.com/about/tech.htm](http://www.computerconfluence.com/about/tech.htm)
5. Cheryl Schmidt Complete 19908, Computer Repair Textbook, Scott Jones, 22-408.
6. Dix, A., Finlay, J., Abowd, G., and Beale, R. 1999. Human-Computer Interaction. Prentice-Hall, Herts. UK. 67-089.
7. Goldberg, M. W. CALOS: Feb, 1997), First Results from an Experiment in Computer-Aided
8. Learning for Operating Systems, in Proceedings of the Twentyeighth SIGCSE Technical Symposium on Computer Science Education. ACM Press. 408-52.
9. Goldberg, M. W. WebCT and First Year Computer Science June, 1997: Student Reaction to and Use of a Web-Based Resource in First Year Computer Science, in Proceedings of the ACM's ITiCSE Conference on Integrating Technology into Computer Science Education. ACM Press. 127-129.
10. Shelly Cashman 2000, Course Technology. About Shelly Cashman Series. Online. Internet. [March 14,]. Available WWW: [Http://www.scseries.com/about_sc.cf](http://www.scseries.com/about_sc.cf)
11. Introducing Python- Modern Computing in Simple Packages – Bill Lubanovic, O.,Reilly Publication
12. Beginning Python: From Novice to Professional, Magnus Lie Hetland, Apress
13. Programming In Python, Dr. Pooja Sharma, BPB

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|--|---|---|---|---|
| ENG445 | Business Communication Basic | L | T | P | C |
| Version 1.0 | Contact Hours – 30 | 2 | 0 | 0 | 2 |
| Pre-requisites/Exposure | Basic knowledge of Programming Languages | | | | |
| Co-requisites | Basic knowledge of python programming language | | | | |

Course Outcomes:

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

CO1: Recall the fundamental concepts of Communicative English.

CO2: Illustrate the components of Communicative English.

CO3: Apply the grammatical knowledge in writing and speaking good English.

CO4: Examine the articles, prepositions, tense, voice, idioms, vocabulary etc. in writing and speaking good English.

CO5: Appraise the significance of advanced methods of communicative English skill development, including audio clipping, argumentative talks, etc.

CO6: Develop good communicative English skills.

Course Content

Unit I (8 hours)

Phonetics; Vowels; Consonants; Vocal cord systems; Speech organs; Oral sounds and nasal sounds; Phonology; Sound structure; Intonation; Understanding pronunciation; Pronouncing individual sounds; Practices.

Unit II (7 hours)

Articles; Prepositions; Morphemes; Morphology; Understanding the word hierarchy; Inflection and derivation; Parts of Speech; Lexical ambiguity; Pluralization; Affixes; Learning vocabulary; Practice vocabulary.

Unit III (7 hours)

Tense; Voice changes; Narrations; Idioms; Putting words together; Formation of phrases; Different types of phrases; Putting the phrases together; Identify different phrases; Phrasal Verbs; Sentences formation; Sentence types; Sentence functions.

Unit IV (8 hours)

Reading short passages; Strategies to read effectively; Listening short audio clips; Strategies to listen effectively; Story telling demonstration; Listening practice; Speaking effectively; Strategies to speak effectively; Practice speaking on different topics.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

SEMESTER II

| | | | | | |
|--------------------------------|--|---|---|---|---|
| GEO481 | Geoinformatics II | L | T | P | C |
| Version 1.0 | Contact Hours – 75 | 2 | 0 | 3 | 4 |
| Pre-requisites/Exposure | Fundamentals of Geoinformatics, Digital Image Processing | | | | |
| Co-requisites | | | | | |

Course Outcomes

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

CO1: Recall the fundamental concepts of spatial and network data.

CO2: Interpret the classified maps and other spatially processed data.

CO3: Apply different classification; single and multi-layer operations, and network analysis.

CO4: Categorize different machine learning based classification and grid-based operations.

CO5: Evaluate the spatial decision support systems.

CO6: Construct advanced classified maps, spatial, and network datasets in the context of spatial decision support system.

Course Content

Unit I: Advanced Image Classification Techniques (18 Hours)

Generic image classification & advanced classification methods – Object-based image classification; Machine learning-based classification (Support Vector Machine, Decision Tree, Random Forest), concepts and techniques of accuracy assessment.

Lab Exercises: Classification optical images using generic and advanced classification (Support Vector Machine, Decision Tree, Random Forest) to generate Land Use and Land Cover Maps; Accuracy Assessment of the Classified Land Use and Land Cover Maps.

Unit II: Spatial Data Analysis (22 Hours)

Fundamentals of spatial data modelling: Distance and Directional Operations; Overview of Tools for Spatial Analysis – Vector Based: Overlay Operations, Single Layer Operations and Multilayer Operation - weighted overlay; Measuring Geographic Distributions - Spatial Analysis – Map Algebra and Grid Based Operations: Local, Focal, Zonal, and Global Analyses; Mean and Median Centres; Cluster and Outlier Analysis; Hotspot Analysis; Spatial Autocorrelation.

Lab Exercises: Overview of tools for spatial analysis – Vector-based overlay operations: Point-in-polygon, line-in-polygon, polygon-in-polygon; Single layer operations: Feature identification, extraction, classification manipulation. Multilayer operation: Union, intersection, symmetrical difference, update, merge, append and dissolve; Topological corrections; Measuring Geographic Distributions: Mean centre, Median centre, and Standard Distance and SDE; Measuring pattern - Cluster and Outlier analysis; Hotspot analysis; Spatial Autocorrelation and Spatial Regression; Spatial analysis – Raster Based: Map algebra, grid-based operations, local, focal, zonal, and global functions.

Unit III: Network Data Analysis (17 Hours)

Network Data Modelling - Evaluation of Network Complexity Using Alpha, Beta, Gamma Indices; Travelling Salesman Problem; Least Cost Path Analysis; Location-Allocation Analysis; Urban Transportation Planning Model.

Lab Exercises: Evaluation of network complexity using Alpha, Beta, Gamma Indices; Least Cost Path Analysis; Location-Allocation Analysis.

Unit IV: Spatial Decision Support Systems (18 Hours)

Spatial Decision Support Systems, Multi criteria decision support system; Concepts of Agent-based modelling; Spatial Interpolation (deterministic and stochastic models).

Lab Exercises: Site-Suitability Analysis and Hazard Zonation Mapping using Multi-Criteria Decision Analysis; Surface Generation from Point Data using Spatial Interpolation (IDW, Spline, and Kriging).

Laboratory Notebook and Viva Voce

Recommended Readings:

1. Jensen, J. R., 2013: Remote Sensing of the Environment, Pearson.
2. Tang, H. and Li, Z-L., 2014: Quantitative Remote Sensing in Thermal Infrared – Theory and Applications, Springer
3. Jensen J. R., 2017: Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall.
4. Vosselman, G. and Mass, H-G. (eds.), 2010: Airborne and Terrestrial Laser Scanning, CRC Press.
5. Lillesand T. M., Kiefer R. W. and Chipman J. W., 2022: Remote Sensing and Image Interpretation, Wiley.
6. Kalacska, M. and Sanchez-Azofeifa, G. A., 2008: Hyperspectral Remote Sensing of Tropical and Subtropical Forests, CRC Press.
7. van der Meer, F. D. and de Jong, S. M., 2002: Imaging Spectrometry – Basic Principles and Prospective Applications, Kluwer Academic Publishers.
8. Shan, J. and Toth, C. K. (eds.), 2018: Topographic Laser Ranging and Scanning – Principles and Processing, CRC Press.
9. Klunzner, C. and Dech, S. (eds.), 2013: Thermal Infrared Remote Sensing – Sensors, Methods, Applications, Springer.
10. Quattrochi, D. A. and Luvall, J. C. (eds.), 2005: Thermal Remote Sensing in Land Surface Processes, CRC Press.
11. Chang, K-T., 2019: Introduction to Geographic Information Systems, McGraw Hill.

12. de Smith, M. J., Goodchild, M. F., Longley, P. A., 2018: Geospatial Analysis: A Comprehensive Guide to Principles, Techniques and Software Tools, Matador.
13. Haining, R., 2010: Spatial Data Analysis – Theory and Practice, Cambridge University Press.
14. Bailey, T. C. and Gatrell, A. C., 1995. Interactive Spatial Data Analysis, Routledge.
15. Burrough, P. A., McDonnell, R. A. and Lloyd, C. D., 2015: Principles of Geographical Information Systems, Oxford University Press.
16. Pick, J. B., 2008: Geo-business GIS in the Digital Organization, Wiley.
17. Singh, R. B. and Murai, S., 1998: Space-informatics for Sustainable Development, Oxford and IBH Pub.
18. Devillers, R. and Jeansoulin, R. (2006). Fundamentals of Spatial Data Quality, ISTE Ltd., USA.
19. Yue-hong Chou (1997). Exploring Spatial Analysis in Geographical Information System, Onword Press, Thomson Learning.
20. Berners-Lee, T. (1996). The World Wide Web: past, present and future. Cambridge, MA: Massachusetts Institute of Technology, Laboratory for Computer Science. <http://www.w3.org/People/Berners-Lee/1996/ppf.html>.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|---|----------|----------|----------|----------|
| GEO482 | Advanced Photogrammetry | L | T | P | C |
| Version 1.0 | Contact Hours – 75 | 2 | 0 | 3 | 4 |
| Pre-requisites/Exposure | UG level Cartography, Surveying and GIS knowledge | | | | |
| Co-requisites | - | | | | |

Course Outcomes

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

CO1: Recall the fundamental concepts of aerial photographs and LiDAR technology.

CO2: Interpret the analog and digital photographs.

CO3: Identify the difference between digital and analog photogrammetry.

CO4: Inspect the role of photogrammetry and LiDAR technology in object height determination and ortho-photo generation.

CO5: Evaluate various applications of aerial photographs and LiDAR data.

CO6: Create analog and digital maps from analog and digital photographs and LiDAR data.

Course Content

Unit I: Introduction to photogrammetry (10 hours)

Introduction to aerial photography – Basic information and specifications of aerial photographs, Photogrammetric terms, applications, benefits, restrictions, and a little history metric vs. non-metric cameras, and photogrammetry camera types.

Unit II: Aerial photogrammetry (20 hours)

Geometric Characteristics of Aerial Photographs- Types of Aerial Photographs: Orthographic vs. Perspective Projection, Map vs. Photograph, Scale of Photograph, Determination the scale, relief displacement and its determination, parallax in photographs and measurement, stereoscopy.

Lab Exercises: Numerical problems on Photographic Scale and Relief Displacement; Determination of Object Heights using Relief Displacement and Parallax; Generation of Maps using Mirror Steroscope.

Unit III Digital Photogrammetry (25 hours)

Transformation between image and object space: collinearity equations, Interior & exterior orientation, Space resection, Space forward intersection and limitations, Aerial triangulation and bundle block adjustment.

Lab Exercises: Product generation: Ortho-photo and DTM generation: DTM/ DEM and DSM, Rectified photo, Orthophoto and True Orthophoto.

Unit IV Photogrammetric Processing for UAV/Drone Data (20 hours)

Introduction to UAVs, their components, classification, and the Drone Policy in India (2021), UAV data processing, UAV data processing software, UAV products and analysis:

Orthorectification and DSM generation using UAV data and drone data, DTM and contour generation, report generation, and volumetric measurement.

Lab Exercises: Generation of Orthomosaics, DSM, DTM and Conntours. report generation, and volumetric measurement

Recommended Readings:

1. Wolf P. R., 2013: Elements of Photogrammetry, McGraw-Hill.
2. Wolf P. R. and Dewitt B. A., 2000: Elements of Photogrammetry: With Applications in GIS, McGraw-Hill.
3. Mikhail, E.J., Campbell, J.S. and Mcglone, J.C., 2019: Introduction to Modern Photogrammetry, Wiley.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|---|----------|----------|----------|----------|
| GEO483 | Geostatistics | L | T | P | C |
| Version 1.0 | Contact Hours – 90 | 0 | 0 | 6 | 4 |
| Pre-requisites/Exposure | Undergraduate level knowledge of Statistics and Probability | | | | |
| Co-requisites | Basic knowledge of computer skills | | | | |

Course Outcomes

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

- CO1. **Explain** the structure of geographical data and distribution characteristics of dataset.
- CO2. **Draw** hypothesis testing assumptions based on the sample dataset.
- CO3. **Examine** hypotheses using suitable testing techniques.
- CO4. **Interpret** location-oriented problems with a focus on spatial data model.

Course Content

Unit I: Geographers’ data exploration (30 Hours)

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

Unit II: Hypothesis Testing (30 Hours)

Hypothesis building- null and alternative, errors, Degree of freedom, Testing assumptions, Test of normality – Shapiro Wilk Test, Small sample and large sample test; Parametric Test – parametric data, Students’ t-Test (paired and independent), Welch test; Non parametric test – Chi Square, ANOVA (one way and two-way), Kruskal–Wallis test.

Unit III: Spatial data visualization (30 Hours)

Pattern and distribution measure of spatial features; point pattern analysis (spatial mean, standard distance, randomness and uniformity), line pattern analysis (directional statistics and network analysis) and areal pattern analysis and measures of regionalization.

Laboratory Notebook and Viva voce

Recommended Readings:

1. Alvi, Z. 1995: Statistical Geography-Methods & Application, Rawat Publications, Jaipur.

2. Ashis Sarkar, Quantitative Analysis in Geography, Blackswan Publishers.
3. Clark, W.A.V. and Hosking, P.L. 1986: Geographical Methods for Geographers, John Wiley and Sons, New York.
4. Croxton, F.E., Cowden, D.J. & Klein, S 1969: Applied General Statistics, PrenticeHall of India Pvt. Ltd., New Delhi.
5. Dickinson, G.C. (1973): Statistical Mapping and Presentation of Statistics.
6. Goon, A.M., Gupta, M.K. & Dasgupta, B. 1992: Basic Statistics, Volume 1, The World Press Pvt. Ltd., Kolkata.
7. Goon, A.M., Gupta, M.K. & Dasgupta, B. 1992: Fundamentals of Statistics, Volume 1, The World Press Pvt. Ltd., Kolkata.
8. Gregory, S. 1985: Statistical Methods and the Geographer, Longman, London.
9. Mahmood, A. 1998: Statistical Methods in Geographical Studies, Rajesh Publications, New Delhi.
10. Monkhouse, F.J. 1971: Maps and Diagrams, Methuen, London.
11. Norcliffe, G.B. 1977: Inferential Statistics for Geographers-An Introduction, Hutchinson and Co.,
12. Pal, S.K. 1998: Statistics for Geo-Scientists- Techniques and Application, Concept Publishing Company, New Delhi.
12. Peter A. Rogerson, Statistical Methods for Geography, Sage Publications.
13. Mehrotra, A.K. 2020: Geostatistics for Beginners. Zorba Books

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|--|----------|----------|----------|----------|
| GEO484 | Geo-spatial Analysis and its Applications Lab | L | T | P | C |
| Version 1.0 | Contact Hours – 90 | 0 | 0 | 6 | 4 |
| Pre-requisites/Exposure | | | | | |
| Co-requisites | | | | | |

Course Outcomes

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

- CO1. **Associate** the utility of topographical maps, aerial photos and satellite images.
- CO2. **Calculate** features like hypsometric curves, stream ordering, Bifurcation Ratio etc.
- CO3. **Construct** land use and land cover map with the help of aerial photos and satellite images.
- CO4. **Combine** both analogue and digital data for identification of features and their changes.

Course Content

Unit I: Introduction to Topographic Mapping (30 Hours)

Geospatial data sources – Comparative utility of topographical maps, aerial photos and satellite images as sources of geographical data; Identification and interpretation of physical features: Identification and mapping of macro and micro geomorphic features; Demarcation and mapping of fluvial features - Long and cross profiles, channel and drainage pattern, channel meandering, river terraces and alluvial fan; Quantitative analysis and measurement of fluvial features - hypsometric curves, Stream ordering, Bifurcation Ratio, channel shifting and bank erosion, Identification and interpretation of cultural features: Preparation of maps showing types and patterns of settlements depending on its sites and situation; Demarcation and mapping of hierarchy of settlements and utility centers, measuring spatial interactions through network analysis; Interpretation and interactions among Physical and Cultural features

Unit II: Interpretation of Aerial Photos (30 Hours)

Basic concepts of remote sensing and aerial photography, Determination of scale, point transfer; Delineation of overlapping and effective area, Identification of physical and cultural features, Preparation of maps and interpretation.

Unit III: Analyses of satellite images (30 Hours)

Extraction of physical features from satellite images of various resolution and band combinations, Extraction of cultural features from satellite images of various resolution and band combinations, Detection of change from multi-dated maps and/or images.

Laboratory Notebook and Viva Voce

Recommended Readings:

1. Dury, G.H. 1972: Map Interpretation, Pitman Publishing, London
2. Ishtiaque, M. 1989: Practical Geography, Heritage Publishers, New Delhi.
3. Monkhouse, F.J. 1971: Maps and Diagrams, Methuen, London

4. Robinson, A.H., Morrison, J.L., Muehrcke, P.C., Kimerling, A.J. and Guptill, S.C. 1995: Elements of Cartography, John Wiley and Sons, New York.
5. Bhatta B., 2021: Remote Sensing and GIS, Oxford Publisher
6. Campbell J. B., 2011: Introduction to Remote Sensing, Guildford Press.
7. Jensen J. R., 2017: Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|--|---|---|---|---|
| CSE585 | Database Management Systems | L | T | P | C |
| Version 1.0 | Contact Hours – 90 | 0 | 0 | 6 | 4 |
| Pre-requisites/Exposure | UG level knowledge of Concept and classification of data | | | | |
| Co-requisites | - | | | | |

Course Outcomes

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

CO1: Recall the concepts of data and knowledge levels.

CO2: Illustrate the ideas of SQL and data normalization.

CO3: Apply the SQL and Join and Subqueries in database management systems.

CO4: Analyze the different functions of SQL and Subqueries.

CO5: Evaluate the utility of knowledge base and expert systems.

CO6: Elaborate the functioning of SQL, database, and normalization.

Course Content:

Unit I: Introduction to Database management system (20 hours)

Database concepts: Data vs information, Database vs file system. DBMS architecture: single tier, two tier, three tier. Types of database model: Hierarchical model, Network model, Relational model, Object-oriented model. Relational data base model. ER models: Entity Set, Relation Ship Set, Cardinality Properties, Type of Entities. Keys: Primary key, Foreign key, Composite key. Relationships: one to one, one to many, many to many. Aggregation, Specialization and Generalization.

Unit II: Normalization (20 hours)

Relational database design: Integrity Constraint, Domain Constrain, Referential Integrity, Functional Dependencies, Closure of Set, Cover and Canonical Cover, Types of Anomalies, Armstrong's axioms, Extended Armstrong's axioms.

Data Base Decomposition: Domain and data dependency, Normal forms: 1NF, 2 NF, 3 NF, BCNF, Dependency preservation, Lossless design.

Unit III: Introduction to SQL (30 hours)

Data definition language (DDL). Data manipulation language (DML). Creating databases and tables. Alter tables. Dropping databases and tables. Insert data into table. Updating the data. Deleting data. Querying data: SELECT statement. SQL data types. Applying constrains: NOT NULL, UNIQUE etc. Common data types in SQL. Filtering data using WHERE clause. Comparison operator. Logical operator. BETWEEN, IN, LIKE and IS NULL. Sorting data using ORDER BY clause. Using LIMIT clause. Aggregate functions and grouping: COUNT, SUM, AVG, MAX, MIN functions. Using GROUP BY clause. Filtering groups with HAVING clause.

Unit IV: Joins and Subqueries (20 hours)

Types of joins: Inner join, Left (outer) join, Right (outer) join, Full (outer) join, cross join. Joining multiple tables. Subqueries and Nested Queries: Using subqueries in SELECT, FROM WHERE clause. Subqueries with EXISTS and NOT EXISTS. Using ANY and ALL with subqueries.

Recommended Readings:

1. Database System Concepts, 6th Edition by Abraham Silberschatz, Henry F. Korth, S. Sudarshan, McGraw-Hill
2. Principles of Database and Knowledge – Base Systems, Vol 1 by J. D. Ullman, Computer Science Press.
3. “Fundamentals of Database Systems”, 5th Edition by R. Elmasri and S. Navathe, Pearson Education
4. “Foundations of Databases”, Reprint by Serge Abiteboul, Richard Hull, Victor Vianu, Addison-Wesley.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|--|---|---|---|---|
| GEO485 | Computer-Aided Design & BIM | L | T | P | C |
| Version 1.0 | Contact Hours – 90 | 0 | 0 | 6 | 4 |
| Pre-requisites/Exposure | Basic knowledge of GIS and CAD | | | | |
| Co-requisites | - | | | | |

Course Outcomes:

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

CO1: Define the various concepts and components of CAD and BIM.

CO2: Interpret the CAD and BIM data.

CO3: Apply CAD techniques and GEE codes to identify various spatial features with special reference to building footprint, LULC, LST, etc.

CO4: Categorize various functions and tools of CAD and BIM.

CO5: Assess the utility of CAD-based data management and mapping.

CO6: Develop maps and images using CAD and BIM techniques.

Course Content

Unit I: Map Making and Data Analysis using CAD (20 hours)

Connecting data from multiple sources; Styling map features; Zooming and changing display; Creating map features; Object identification from data table; Object editing; Legend making; Map publishing; Exploring data portals; Data Analysis – Visualization of surface data; Data analysis with external information using Join function; Proximity analysis; Report generation.

Unit II: Data Management using CAD (25 hours)

Data Management – Data conversion from drawing layers to feature classes; Drawing Layer Export; Connection to parcel data; Splitting a polygon feature; Connection to external database; Calculation; Theme creation; Publish to MapGuide.

Unit III: Building Information Modelling (20 hours)

Concepts and benefits of BIM; Agile Project Management; Building Management System; Project-based Learning and use of simulated projects; BIM Implementation and Procurement Routes

Unit IV: Building Footprint Mapping using CAD (25 hours)

Building footprint mapping from satellite images, aerial and drone photographs, and OpenStreet Maps; Role of AI in building footprint mapping.

Recommended Readings:

1. AutoCAD Map 3D Tutorials. Autodesk.
2. Ellis, R. and Martin, R. 2018. A Practical Guide to AutoCAD Map 3D 2019. CADapult Press
3. Dastbaz, M. et al. (eds) 2017. Building Information Modelling, Building Performance, Design and Smart Construction. Springer

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|--|----------|----------|----------|----------|
| CSE586 | Python for Geospatial analysis | L | T | P | C |
| Version 1.0 | Contact Hours – 45 | 0 | 0 | 3 | 2 |
| Pre-requisites/Exposure | Basic knowledge of Programming Languages | | | | |
| Co-requisites | Basic knowledge of python programming language | | | | |

Course Outcomes:

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

CO1: Recall the fundamental concepts algorithms and statistics.

CO2: Illustrate different applications of ArcPy, NumPy, Pandas, GeoDataFrames, etc.

CO3: Apply different Python libraries.

CO4: Examine the utility of Python machine learning and real-world applications.

CO5: Evaluate Python coding in geoscience and geospatial data processing.

CO6: Develop Python codes for statistical and geoscientific analysis.

Course Content

Unit I: The application of machine learning in geoscience (12 hours)

Overview of machine learning and its relevance to geoscience. Types of machine learning: supervised, unsupervised and reinforcement learning. Case studies of machine learning applications in geoscience. Introduction to Numpy: arrays, array operations and basic functions. Statistical operations and linear algebra with Numpy. Introduction to Arcpy and its functionalities. Working with shapefiles and geodatabases. Spatial analysis and geoprocessing with Arcpy. Basics of Matplotlib: plotting, styling and customizing plots, creating geospatial visualizations. Introduction to Seaborn: Statistical data visualization.

Unit II: Statistics for geoscience (11 hours)

Introduction to statistics in geoscience. Types of data: qualitative vs quantitative, continuous vs discrete. Descriptive statistics: mean, median, mode, standard deviation, and variance. Introduction to data cleaning using Pandas: Handling of missing value: imputation, removal and interpolation. Detecting outliers and correcting outliers. Data preprocessing: scaling, normalization and transformation. Encoding categorical variables. Feature engineering for geoscientific data.

Unit III: Advanced geospatial data processing and analysis (11 hours)

Introduction to Geopandas: creating and manipulating GeoDataFrames. Spatial operations: joins, buffers and overlays. Introduction to image processing concepts: filtering, edge detection and thresholding. Python libraries for image processing: PIL, OpenCV and scikit-image. Spatial data preprocessing: data cleaning and transformations. Handling large geospatial datasets. Mosaicking of images, handling image alignment and blending. Georeferencing: techniques for georeferencing images, applying transformation and projection. Map algebra: Raster data operations: local, focal, zonal and global.

Unit IV: The basics of machine learning and case studies (11 hours)

Introduction to regression and classification. Supervised machine learning algorithm: Linear regression, bivariate regression, Concept of correlation in machine learning, Logistic regression, decision trees, support vector machine. Introduction to clustering. Unsupervised machine learning algorithm: K means clustering, hierarchical clustering, and principle component analysis. Introduction to scikit-learn. Case study: Real world application of machine learning.

Recommended Readings:

1. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.
2. John V Guttag, "Introduction to Computation and Programming Using Python", Revised and expanded Edition, MIT Press, 2013
3. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012.
4. Paul Gries, Jennifer Campbell and Jason Montojo, "Practical Programming: An Introduction to Computer Science using Python 3", Second edition, Pragmatic Programmers, LLC,2013.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|---|---|---|---|---|
| GEO486 | Dissertation I | L | T | P | C |
| | | | | 3 | 2 |
| Pre-requisites/Exposure | In depth knowledge on masters level special paper | | | | |
| Co-requisites | English writing and communication skill | | | | |

Course Outcomes

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

CO1: Recall the fundamental concepts of research objectives, process, hypothesis.

CO2: Compare different research types and data collection methods.

CO3: Organize literature review and samples.

CO4: Classify different sampling types and citation methods.

CO5: Evaluate research problems.

CO6: Construct the dissertation file with literature review and research objectives.

Course Content

Unit I: Review of Literature (15 Hours)

Unit II: Identifying the Research Questions & Objective of the study (15 Hours)

Unit II: Documentation and Presentation on Literature review and Viva (15 Hours)

Recommended Readings:

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

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

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|--------------------------------|--|---|---|---|---|
| ENG446 | Business Communication Intermediate | L | T | P | C |
| Version 1.0 | Contact Hours – 30 | 2 | 0 | 0 | 2 |
| Pre-requisites/Exposure | Basic knowledge of Programming Languages | | | | |
| Co-requisites | Basic knowledge of python programming language | | | | |

Course Outcomes:

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

CO1: Recall the intermediate concepts of Communicative English.

CO2: Illustrate the components of Communicative English.

CO3: Apply the grammatical knowledge in writing and speaking good English.

CO4: Examine the articles, prepositions, tense, voice, idioms, vocabulary etc. in writing and speaking good English.

CO5: Appraise the significance of advanced methods of communicative English skill development, including audio clipping, argumentative talks, etc.

CO6: Develop good communicative English skills.

Course Content

Unit 1 (8 hours)

Verbs; Types of verbs; Use of verbs; Constructing sentences from verbs; Subject-verb agreement; Speech errors; Speech acts; Understanding speech, pronunciation, vocabulary from audio/video clips;

Unit 2 (7 hours)

Intermediate level vocabulary; Synonyms and antonyms; Introducing syntax; Rules to form sentences; Forming complex sentences; Understanding ambiguous phrases and sentences; One word substitution; Stopping mental translations; Strategies to speak fluently and confidently.

Unit 3 (8 hours)

Narratives; One to one communication; Introducing oneself; Classroom discussion; Interview demonstration; Intermediate speaking practices; Telling about yourself; Telling about your hobbies, education, job and passion; Breaking the ice.

Unit 4 (7 hours)

Listening larger audio clips; Listening to discussion; Listening business communication; Listening exercises; Practice speaking after listening; Identifying the main theme of the discussion/debate.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

SEMESTER: III

| | | | | | |
|--------------------------------|--|----------|----------|----------|----------|
| GEO550 | Geoinformatics III | L | T | P | C |
| Version 1.0 | Contact Hours – 75 | 2 | 0 | 3 | 4 |
| Pre-requisites/Exposure | Fundamentals of Geoinformatics, Digital Image Processing | | | | |
| Co-requisites | | | | | |

Course Outcomes

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

CO1: Define the terms thermal, microwave, hyperspectral, and LiDAR remote sensing.

CO2: Illustrate the concepts of thermal, microwave, hyperspectral, and LiDAR remote sensing.

CO3: Apply the various functions of thermal, microwave, hyperspectral, and LiDAR remote sensing.

CO4: Examine the utility of thermal, microwave, hyperspectral, and LiDAR remote sensing.

CO5: Evaluate application of thermal, microwave, hyperspectral, and LiDAR remote sensing in coal fire mapping, urban heat island studies, biomass estimation, object height determination.

CO6: Construct thermal, backscatter, classified images and digital surface models.

Course Content

Unit I: Thermal Remote Sensing (20 Hours)

Thermal Radiation Principles: Radiant vs. Kinetic Temperature; Blackbody Radiation law; Interaction of thermal radiation with terrain elements; Thermal infrared domain and atmospheric windows; Kirchhoff's law and Emissivity; Thermal infra-red sensors; Daytime and nighttime data acquisition; Pre-processing of thermal sensor data; TIR spectroscopy; Thermal sensing through UAV; Application of thermal remote sensing in forest fire, surface coal fire, and urban heat island studies.

Lab Exercises: Generation of brightness temperature map; Determination of Surface Emissivity from NDVI; Estimation of Land Surface Temperature; Delineation of Urban Heat Islands, Surface Coal Fire Mapping.

Unit II: Microwave Remote Sensing (20 Hours)

Advantages and limitations of microwave remote sensing; Active and Passive Microwave Sensors; Wavelength, frequency, and pulse length; Geometric characteristics of SLAR images: azimuth and range direction, depression and incident angles, polarization, range and azimuth resolutions; Numerical Problems on Radar Resolution; RADAR relief displacement: foreshortening, layover, shadows, speckle; Concept and functioning of SAR; RADAR environmental considerations: surface roughness characteristics, electrical characteristics and moisture content, vegetation, water, and urban responses; RADAR Interferometry; Functioning of Ground Penetrating RADAR.

Lab Exercises: Intensity and Phase; Thermal Noise and Border Noise Correction of microwave images; Calibration and Co-registration; Terrain Correction and Back-Scatter Image Generation; Applications in Soil Moisture and Above Ground Biomass studies.

Unit III: Hyperspectral Remote Sensing (20 Hours)

Imaging spectrometry and hyperspectral cube; Spectral end member and spectral libraries; Atmospheric correction of hyperspectral images; n-dimensional visualization; Spectral Angle Mapper Classification; Minimum Noise Fraction; Pixel Purity Index; Spectral Feature Filtering; Spectral Unmixing; Applications of hyperspectral remote sensing in forestry, geology, and urban studies.

Lab Exercises: Browsing image spectra and comparison with the library spectra; Removal of residual calibration errors; End member selection and Spectral Angle Mapper Classification; Spectral feature fitting and analysis; MNF Transformation; Identification of spectrally pure pixels; n-dimensional visualization; Spectral Unmixing; Vegetation hyperspectral analysis.

Unit IV: LiDAR Remote Sensing (15 Hours)

Basic components and physical principles of LiDAR scanning system; Airborne and spaceborne laser profilers; Advantages and limitations of airborne laser scanning; Digital Surface Models; LiDAR accuracy; Canopy surface height mapping; Terrestrial Laser Scanning System; Building extraction and 3D reconstruction.

Lab Exercises: Point cloud data visualization; Generation elevation models from Point Cloud Data based on the return signals; Determination of Object Heights from LiDAR data.

Recommended Readings:

1. Jensen, J. R., 2011: Remote Sensing of the Environment, Pearson.
2. Tang, H. and Li, Z-L., 2014: Quantitative Remote Sensing in Thermal Infrared – Theory and Applications, Springer
3. Jensen J. R., 2017: Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall.
4. Vosselman, G. and Mass, H-G. (eds.), 2010: Airborne and Terrestrial Laser Scanning, CRC Press.
5. Lillesand T. M., Kiefer R. W. and Chipman J. W., 2022: Remote Sensing and Image Interpretation, Wiley.
6. Kalacska, M. and Sanchez-Azofeifa, G. A., 2008: Hyperspectral Remote Sensing of Tropical and Subtropical Forests, CRC Press.
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8. Shan, J. and Toth, C. K. (eds.), 2018: Topographic Laser Ranging and Scanning – Principles and Processing, CRC Press.
9. Kluenzer, C. and Dech, S. (eds.), 2013: Thermal Infrared Remote Sensing – Sensors, Methods, Applications, Springer.

10. Quattrochi, D. A. and Luvall, J. C. (eds.), 2005: Thermal Remote Sensing in Land Surface Processes, CRC Press.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|--|---|---|---|---|
| GEO551 | Advanced Computation using Geo-AI | L | T | P | C |
| Version 1.0 | Contact Hours – 75 | 2 | 0 | 3 | 4 |
| Pre-requisites/Exposure | Basic knowledge of Machine Learning and Image Processing | | | | |
| Co-requisites | - | | | | |

Course Outcomes:

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

CO1: Define the various concepts and components of Geo-AI.

CO2: Classify different deep learning algorithms.

CO3: Apply various machine learning and deep learning algorithms in natural resources and urban planning.

CO4: Examine the role of Geo-AI in natural resources and urban planning.

CO5: Evaluate the various Geo-AI techniques and deep learning algorithms.

CO6: Develop the applications of Geo-AI in natural resources and urban planning.

Course Content

Unit I: Geospatial Artificial Intelligence Algorithms (25 hours)

Concept of Geo-AI; Introduction to Deep Learning – Model Training, Model Inferencing, Exploratory Analysis; Machine Learning vs. Deep Learning; Working principles and architecture of deep learning with special reference to ANN, CNN, RNN, and DNN.

Unit II: Applications of Geo-AI in Natural Resources (30 hours)

Applications of machine learning and deep learning – runoff assessment; flood susceptibility and risk analysis; ground water potential zonation; ground water quality modelling; forest detection and area estimation; species mapping; forest fire risk analysis; soil mapping and erosion assessment.

Lab Exercises: Applications of Geo-AI in runoff estimation; flood risk mapping; groundwater potential zonation mapping; forest fire risk mapping; soil erosion mapping.

Unit III: Applications of Geo-AI in Urban Planning Lab (20 hours)

Applications of machine learning and deep learning – urban land use planning; urban growth modelling; urban heat island studies; crime hotspot analysis.

Lab Exercises: Applications of Geo-AI in LULC mapping, urban growth mapping; UHI mapping; crime hotspot mapping.

Recommended Readings:

1. Cresson, R. 2020. Deep Learning for Remote Sensing Images with Open Source Software. CRC Press.
2. Lary, D.J., Alavi, A.H., Gandomi, A.H., and Walker, A.L. 2016. Machine learning in geosciences and remote sensing. *Geoscience Frontiers*. 7. 3-10.
3. Dtissibe, F.Y., Ari, A.A.A., Abboubakar, H., Njoya, A.N., Mohamadou, A., Thiare, O. 2024. A comparative study of Machine Learning and Deep Learning methods for flood forecasting in the Far-North region, Cameroon. *Scientific African*. 23. e02053.
4. Mohammadi, B. 2021. A review on the applications of machine learning for runoff modeling. *Sustainable Water Resources Management*. 7. 98.
5. Madhuri, R., Sistla, S., and Raju, K.S. 2021. Application of machine learning algorithms for flood susceptibility assessment and risk management. *Journal of Water and Climate Change*. 12. 2608-2623.
6. Haggerty, R., Sun, J., Yu, H., and Li, Y. 2023. Application of machine learning in groundwater quality modeling – A comprehensive review. *Water Research*. 233. 119745.
7. Lee, S., Hyun, Y., Lee, S., and Lee, M-J. 2020. Groundwater potential mapping using remote sensing and GIS-based machine learning techniques. *Remote Sensing*. 12. 1200.
8. Rihan, M., Bindajam, A.A., Talukdar, S., Shahfahad, Naikoo, M.W., Mallick, J., and Rahman, A. 2023. Forest fire susceptibility mapping with sensitivity and uncertainty analysis using machine learning and deep learning algorithms. *Advances in Space Research*. 72. 426-443.
9. Saha, S., Bera, B., Shit, P.K., Bhattacharjee, S., and Sengupta, N. 2023. Prediction of forest fire susceptibility applying machine and deep learning algorithms for conservation priorities of forest resources. *Remote Sensing Applications: Society and Environment*. 29. 100917.
10. Talebiesfandarani, S. and Shamsoddini, A. 2022. Global-scale biomass estimation based on machine learning and deep learning methods. *Remote Sensing Applications: Society and Environment*. 28. 100868.
11. Lukas, J., Kolb, S., Heinbuch, J., Willig, L., Plankenbühler, T., Müller, D., and Karl, J. 2023. Image-based biomass characterization: Comparison of conventional image processing and a deep learning approach. *Fuel*. 341. 127705.
12. Anand, A., Pandey, M.K., Prashant K. Srivastava, P.K., Gupta, A., and Khan, M.L. 2021. Integrating multi-sensors data for species distribution mapping using deep learning and envelope models. *Remote Sensing*. 13. 3284.
13. Sothe, C., De Almeida, C.M., Schimalskib, M.B., Liesenberg, V., La Rosac, L.E.C., Castroc, J.D.B. and Feitosac, R.Q. 2019. A comparison of machine and deep-learning algorithms applied to multisource data for a subtropical forest area classification. *International Journal of Remote Sensing*. 41. 1943-1969.
14. Machichi, M.A., El Mansouri, I, Imani, Y., Bourja, O., Lahlou, O., Zennayi, Y., Bourzeix, F., Houmma, I.H., and Hadria, R. 2023. Crop mapping using supervised machine learning and deep learning: a systematic literature review, *International Journal of Remote Sensing*, 44. 2717-2753.

15. Klompenburga, T.V., Kassahuna, A., and Catal, C. 2020. Crop yield prediction using machine learning: A systematic literature review. *Computers and Electronics in Agriculture*. 177. 105709.
16. Bouguettaya, A., Zarzour, H., Kechida, A., and Taberkit, A.M. 2022. Deep learning techniques to classify agricultural crops through UAV imagery: a review. *Neural Computing and Applications*. 34. 9511–9536.
17. Gharaibeh, A.A., Jaradat, M.A., and Kanaan, L.M. 2023. A Machine Learning Framework for Assessing Urban Growth of Cities and Suitability Analysis. *Land*. 12. 214.
18. Gómez, J.A., Patiño, J.E., Duque, J.C. and Passos, S. 2020. Spatiotemporal modeling of urban growth using machine learning. *Remote Sensing*. 12. 109.
19. Chaturvedi, V., and de Vries, W.T. 2021. Machine learning algorithms for urban land use planning: A review. *Urban Science*. 5. 68.
20. Shi, W., Goodchild, M.F., Batty, M., Kwan, M-P., and Zhang, A. (eds.). 2021. *Urban Informatics*. Springer.
21. Addas, A. 2023. Machine learning techniques to map the impact of urban heat island: Investigating the city of Jeddah. *Land*. 12. 1159.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|--|---|---|---|---|
| GEO552 | Cloud Computation for Spatial Data Analysis | L | T | P | C |
| Version 1.0 | Contact Hours – 90 | 0 | 0 | 6 | 4 |
| Pre-requisites/Exposure | Basic knowledge of GIS and Java Script | | | | |
| Co-requisites | Basic knowledge of computer skills | | | | |

Course Outcomes

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

CO1: Recall the basic concepts of GEE.

CO2: Interpret the interactive and dynamic maps.

CO3: Identify the components of GEE.

CO4: Categorize the applications of GEE.

CO5: Evaluate the web services standards and interoperability.

CO6: Create web layers, interactive and dynamic maps.

Course Content (45 hours)

Unit I: Introduction to GEE (20 hours)

Introduction to Google Earth Engine; Filtering and displaying image data; Import and Export Raster and Vector Data; Image filtering

Unit II: Spatial Data Analysis using GEE (25 hours)

Calculating spectral indices: assessing vegetation, water, glacier, burnt area, and built-up area; Time series data analysis; Iteration; Estimation of Land Surface Temperature.

Unit III: Digital Image Classification (25 hours)

Classification in GEE; Collecting training data using the drawing tools or Fusion Tables; Supervised classification, Accuracy assessment; Unsupervised classification

Unit IV: Advanced Applications and Exporting Results (20 hours)

Change detection, Zonal statistics and region reduction, Exporting images and tables (GeoTIFF, CSV), Introduction to Python API and integration with Jupyter Notebook

Laboratory Note Book and Viva Voce

Recommended Readings:

1. Pinde Fu, 2015, Getting to Know Web GIS. ESRI Press. Redlands, CA. ISBN-13: 978-1589483842 ISBN-10: 1589483847.
2. Android Programming Tutorials: Easy-To-Follow Training-Style Exercises on Android Application Development. CommonsWare, LLC, 2009. 0981678025.
3. Cardille, J.A., Crowley, M.A., Saah, D., and Clinton, N.E. (eds.) 2024. Cloud-Based Remote Sensing with Google Earth Engine – Fundamentals and Applications. Springer.
4. Kumar, L. and Mutanga, O. (eds.) 2019. Google Earth Engine Applications. MDPI.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|---|---|---|---|---|
| GEO554 | Spatial Data Science with R | L | T | P | C |
| Version 1.0 | Contact Hours – 90 | 0 | 0 | 6 | 4 |
| Pre-requisites/Exposure | Knowledge of Programming language, Basic knowledge of GIS | | | | |
| Co-requisites | - | | | | |

Course Outcomes

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

CO1: Recall the basics of R programming, remote sensing, GIS.

CO2: Demonstrate various data manipulation, visualization, remote sensing, and GIS functions in R.

CO3: Apply R programming in different remote sensing, GIS, and spatial statistical analyses.

CO4: Examine the advantages of R programming in handling and visualizing spatial data.

CO5: Assess the utility of R programming in performing spatial and statistical analyses.

CO6: Develop different spatial outputs using R programming.

Course Content

Unit I: Basics of R programming (20 Hours)

Introduction of R programming, data types, variables, vectors, scalars, data frames, lists, matrices, arrays, classes, arithmetic and boolean operators and values, structures, control statements, loops, recursion, Scoping Rules, Loop functions.

Unit II: Data manipulation and data visualization (20 Hours)

Functions, math functions, linear algebra operation, probability distributions: normal, binomial, poisson; graphics: creating graphs, customizing graphs box plot, histogram, pie graph, line chart, scatterplot.

Unit III: Basic Remote Sensing and GIS function in R (30 Hours)

Setting up R: Setting up RStudio, Introduction to RStudio, Package installations, File Organization, Working directory; GIS and RS Data handling in R: Read raster data in R, projection assignment, reprojection, resampling, preparation of FCC in R, subsetting, band arithmetic; development of different indices (NDVI, NDBI, NDWI etc.) with Landsat 5, Landsat 8, Aster and MODIS data; Read vector data in R, explore .shp file attributes in R, basic visualisation with .shp file, splitting and merging of .shp file, Spatial Attribute Analysis.

Unit IV: Spatial Statistics with R (20 Hours)

Point Pattern Analysis and Hotspot Mapping; Areal Pattern analysis and - Moran's I; Gettis's G; Spatial correlation and Spatial prediction

Recommended Readings:

1. Bivand, R. S., Pebesma, E. J., Gómez-Rubio, V., & Pebesma, E. J. (2008). Applied spatial data analysis with R (Vol. 747248717, pp. 237-268). New York: Springer.
2. Wickham, H., & Grolemund, G. (2016). R for data science: import, tidy, transform, visualize, and model data. " O'Reilly Media, Inc."
3. Xie, Y., Allaire, J. J., & Grolemund, G. (2018). R markdown: The definitive guide. CRC Press.
4. Irizarry, R. A. (2019). Introduction to data science: data analysis and prediction algorithms with R. CRC Press.
5. Lillesand T. M., Kiefer R. W. and Chipman J. W., 2004: Remote Sensing and Image Interpretation, Wiley.(Wiley Student Edition).
6. Singh R. B. and Murai S., 1998: Space-informatics for Sustainable Development, Oxford and IBH Pub.
7. Anselin, L., & Rey, S. J. (2010). Perspectives on spatial data analysis. In Perspectives on Spatial Data Analysis (pp. 1-20). Springer, Berlin, Heidelberg.
8. Alvi, Z. 1995: Statistical Geography-Methods & Application, RawatPublications,Jaipur.
9. Croxton, F.E., Cowden, D.J. & Klein, S 1969: Applied General Statistics, PrenticeHall of India Pvt. Ltd.,New Delhi

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|---|----------|----------|----------|----------|
| GEO555 | Web and Mobile GIS | L | T | P | C |
| Version 1.0 | Contact Hours – 90 | 0 | 0 | 6 | 4 |
| Pre-requisites/Exposure | Knowledge of Programming language, Basic knowledge of GIS | | | | |
| Co-requisites | - | | | | |

Course Outcomes

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

CO1. Recall the fundamental concepts of GIS

CO2. Illustrate principles, techniques and basics of Web GIS.

CO3. Draw story maps using featured web services.

CO4. Examine the advantages of Web GIS in handling and visualizing spatial data

CO5. Explain the applications and features of Mobile-GIS with a focus on developing mobile GIS apps.

CO6. Develop an independent Web GIS application.

Course Content

Unit I: Web GIS Basics and Application (20 Hours)

Web GIS basics and applications; create a map tour application; Cloud GIS - Geoweb Services and Geoportal Application; Create web layers, maps and Smart mapping.

Unit II: Web Service and VGI (20 Hours)

Web services overview, volunteered geographic information, web editing and feature Service; Publish and use hosted feature services to collect VGI; Story maps and more web app templates - Create a story map that uses multiple templates; 3D Web GIS.

Unit III: Mobile GIS and Application (25 Hours)

Introduction to Mobile GIS; Data Capture and collection through Mobile GIS; Real-time Web GIS - Create a real-time web GIS app using Operations Dashboard; Introducing contemporary SDK for developing mobile GIS applications.

Unit IV: Geo-server and Map Services (25 Hours)

Spatial Analysis online - Create a web app supporting spatial analysis; Map services; Web Services Standards & Interoperability - Publish and use dynamic map services with time animation.

Recommended Readings:

1. Pinde Fu, 2015, Getting to Know Web GIS. ESRI Press. Redlands, CA. ISBN-13: 978-1589483842 ISBN-10: 1589483847.
2. Android Programming Tutorials: Easy-To-Follow Training-Style Exercises on Android Application Development. CommonsWare, LLC, 2009. 0981678025.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|---|----------|----------|----------|----------|
| CSE587 | JavaScript for Geospatial Applications | L | T | P | C |
| Version 1.0 | Contact Hours – 45 | 0 | 0 | 3 | 2 |
| Pre-requisites/Exposure | Basic knowledge of Programming Language | | | | |
| Co-requisites | - | | | | |

Course Outcome

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

CO1: Recall the fundamental concepts of data types and Java scripting.

CO2: Illustrate the various statements and event handlers.

CO3: Apply the various condition statements.

CO4: Examine the utility of condition statements and event handlers.

CO5: Evaluate various advanced topics, e.g. GeoJSON, Mapbox, GEE API, etc..

CO6: Develop codes using JavaScript on condition statements, object, and event handling.

Course Content

Unit I: JavaScript Fundamentals (10 hours)

Introduction to JavaScript: Client-side Scripting and Server-side scripting; importance of Java Script, Creating Sample Program; Data Type and Operators; Various Data Type and its importance Understanding and Using Types of Operators;

Unit II: JavaScript Statements (11 hours)

If Else and Switch case, var, Iterative Mechanisms: Various Lopping Mechanism, Understanding Loops. While Loop, for loop, for...in, Loop Control: Break, Comment and Continue Core JavaScript: Array, Number, Boolean, Date Function, Math, Number, Object, String, RegExp.

Unit III: Basics and Essential Tools (12 hours)

Introduction to Geospatial Data and JavaScript; Working with GeoJSON, Creating and manipulating GeoJSON data, Introduction to Leaflet: Basic map setup with Leaflet, adding markers and layers to the map, Displaying GeoJSON data on a Leaflet map, Leaflet Advanced Features, Handling user interactions (click, hover); Introduction to APIs, Integrating APIs for Geospatial Data: Fetching data from external APIs (e.g., OpenStreetMap, Google Maps, Real-Time Weather Data Visualization);

Unit IV: Advanced Topics and Practical Applications (12 hours)

Introduction to Mapbox GL JS: Overview of Mapbox GL JS, Basic map setup with Mapbox, Styling and customizing Mapbox maps, Adding layers and sources; Integrating Google Maps with JavaScript: Overview of Google Maps JavaScript API, Setting up and configuring Google Maps, Adding markers, polylines, and polygons, Customizing the map with styles and layers; Using Google Earth with JavaScript: Google Earth Engine API setup, Importing and visualizing geospatial data;

Laboratory Notebook and Viva Voce

Recommended Reading:

1. Eloquent JavaScript: A Modern Introduction to Programming, Marijn Haverbeke
2. JavaScript: The Definitive Guide (6th), Davis Flanagan, O'Reilly
3. Learn JavaScript VISUALLY, Ivelin Demirov, Nai Inc.
4. Leaflet.js Essentials, Paul Crickard III
5. Mastering JavaScript High Performance, Chad R. Adams
6. Google Maps JavaScript API Cookbook, Alper Dincer and Balkan Uraz
7. Learning Three.js: The JavaScript 3D Library for WebGL, Jos Dirksen

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|--|----------|----------|----------|----------|
| GEO556 | Dissertation II | L | T | P | C |
| | | 0 | 0 | 3 | 2 |
| Pre-requisites/Exposure | In depth knowledge on master's level special paper | | | | |
| Co-requisites | English writing and communication skill | | | | |

Course Outcomes

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

CO1: Recall the fundamental concepts of research objectives, process, hypothesis.

CO2: Explain different research methods.

CO3: Organize literature review and samples.

CO4: Compare between primary and secondary data.

CO5: Evaluate research problems based on the collected data analysis.

CO6: Construct the documents and presentation on research data and methodology.

Course Content

Unit I: Methodology Selection (10 Hours)

Unit II: Collection of Primary & Secondary Data (10 Hours)

Unit III: Preliminary data analysis (15 Hours)

Unit IV: Documentation and Presentation on Research Data and Methodology and Viva (10 Hours)

Recommended Readings:

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

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

| Cos | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|--------------|--------------|--------------|
| CO 1 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 1 |
| CO 2 | 1 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 |
| CO 3 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 1 |
| CO 4 | 1 | 1 | 1 | 3 | 2 | 3 | 1 | 2 | 2 | 1 | 1 | 0 | 2 | 1 |
| CO 5 | 0 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 0 |
| CO 6 | 1 | 1 | 2 | 1 | 2 | 3 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 1 |

| | | | | | |
|--------------------------------|--|---|---|---|---|
| GEO553 | Startup Skill Development | L | T | P | C |
| Version 1.0 | Contact Hours – 30 | 2 | 0 | 0 | 2 |
| Pre-requisites/Exposure | Basic knowledge of Business Communication | | | | |
| Co-requisites | Basic knowledge of Business Communication Skills | | | | |

Course Outcomes:

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

Upon completion of this course, students will be able to:

CO1: Remember fundamental concepts and terminologies of entrepreneurship, startups, and business models.

CO2: Understand the processes and stages of startup development, including ideation, market analysis, and fundraising.

CO3: Apply geoinformatics knowledge to develop innovative and practical solutions for startup ventures.

CO4: Analyze market trends, customer needs, and competitive landscapes to identify viable business opportunities.

CO5: Evaluate business ideation and market for geospatial startups.

CO6: Create a preliminary startup business plan or proposal tailored to the geoinformatics domain.

Course Content

Unit I: Introduction to Startups and Entrepreneurship (7 hours)

Entrepreneurship: Definition, types, and characteristics, Understanding startups: Definitions, lifecycle, and types, Role of innovation and technology in startups, Importance of geoinformatics in entrepreneurial ventures, Challenges and opportunities in geospatial startups.

Unit II: Business Ideation and Market Analysis (8 hours)

Generating and validating ideas for geospatial startups, understanding market dynamics and customer needs, Basics of market research and competitor analysis, Identifying gaps in the geospatial domain for startup opportunities, case studies of successful geoinformatics startups.

Unit III: Business Models, Funding, and Legal Frameworks (7 hours)

Types of business models (B2B, B2C, SaaS, etc.) in geospatial startups, Basics of financial planning, bootstrapping, and fundraising, Venture capital, angel investors, and government funding schemes, Intellectual property rights (IPR) and legal considerations for startups, the role of incubators, accelerators, and startup ecosystems.

Unit IV: Startup Execution and Strategic Planning (8 hours)

Developing a business plan: Vision, mission, and goals; risk management and strategic decision-making; marketing, branding, and customer acquisition strategies; scaling up: Operational and team-building strategies; preparing a prototype and pitching to investors.

References

- Blank, S., & Dorf, B. (2020). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. Wiley.

2. Ries, E. (2011). *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*. Crown Business.
3. Osterwalder, A., & Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. Wiley.
4. Sarasvathy, S. D. (2001). *Effectuation: Elements of Entrepreneurial Expertise*. Edward Elgar Publishing.
5. Startup India Portal (<https://www.startupindia.gov.in/>): Guidelines, funding schemes, and resources.
6. Articles and case studies on geospatial startups (e.g., DroneDeploy, Planet Labs, Mapbox).

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|--|---|---|---|---|
| ENG447 | Business Communication Advanced | L | T | P | C |
| Version 1.0 | Contact Hours – 30 | 2 | 0 | 0 | 2 |
| Pre-requisites/Exposure | Basic knowledge of Programming Languages | | | | |
| Co-requisites | Basic knowledge of python programming language | | | | |

Course Outcomes:

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

CO1: Recall the advanced concepts of Communicative English.

CO2: Illustrate the components of Communicative English.

CO3: Apply the grammatical knowledge in writing and speaking good English.

CO4: Examine the articles, prepositions, tense, voice, idioms, vocabulary etc. in writing and speaking good English.

CO5: Appraise the significance of advanced methods of communicative English skill development, including audio clipping, argumentative talks, etc.

CO6: Develop good communicative English skills.

Course Content

Unit 1 (8 hours)

Advanced vocabulary; Participation in debate competition; Public speaking; Question-answer; Reading larger texts; Talk about sports, politics, climate etc.; Interview demonstration, maintaining eye contacts, body language, sitting postures, opening sentences, attempting questions.

Unit 2 (7 hours)

Understanding contexts; Use contextually relevant vocabulary; Understanding the principles of speaking effectively; Speaking correctly and confidently; Defending your answers/arguments; Strategies to Speak confidently and clearly; Practice correct pronunciation.

Unit 3 (8 hours)

Discussing a wide variety of topics; Taking up an argument; Over coming communication barriers; Listening to Ted talks, movie clips, audio clips; Business discussion; Enhancing communicative English.

Unit 4 (7 hours)

Understanding speaking skills; Ways to improve speaking skills; Practice speaking; Develop communicative English.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

| Cos | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|--------------|--------------|--------------|
| CO 1 | 1 | 1 | 2 | 1 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 1 | 2 | 1 |
| CO 2 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO 3 | 1 | 2 | 2 | 1 | 2 | 3 | 2 | 1 | 2 | 1 | 3 | 1 | 1 | 1 |
| CO 4 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 0 | 1 | 2 | 1 |
| CO 5 | 1 | 1 | 0 | 2 | 2 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO 6 | 1 | 1 | 2 | 1 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 1 | 2 | 0 |

SEMESTER: IV

| | | | | | |
|--------------------------------|--------------------------------------|---|---|---|---|
| GEO557 | Internship | L | T | P | C |
| Version 1.0 | Contact Hours – 150 | | | | 8 |
| Pre-requisites/Exposure | Undergraduate knowledge of Geography | | | | |
| Co-requisites | - | | | | |

Course Outcomes

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

CO1: Recall the fundamental concepts, tools, and techniques of geoinformatics relevant to real-world applications during internship.

CO2: Explain the process, workflows, and methodologies employed in the host organization's geospatial projects.

CO3: Apply tools and techniques of geoinformatics to solve domain-specific problems encountered during the internship.

CO4: Analyze geospatial datasets and project requirements to identify challenges and propose viable solutions within the internship context.

CO5: Appraise the effectiveness of geospatial methods and tools used in the internship and suggest improvements or alternative approaches.

CO6: Develop and present a comprehensive internship report detailing the objectives, methods, results and recommendations based on internship experience.

Course Content

(180 Hours)

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

Word Limit = 4000 (maximum) excluding Tables and Appendix (Computer typed, Line Spacing =

1½, Arial Narrow / Times New Roman / Helvetica 10 / 11/ 12)

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

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|---|----------|----------|----------|----------|
| GEO558 | Dissertation III | L | T | P | C |
| Version 1.0 | Contact Hours – 150 | | | | 8 |
| Pre-requisites/Exposure | In-depth knowledge of master’s level special paper and research methodology | | | | |
| Co-requisites | Statistics and GIS software knowledge and writing skill | | | | |

Course Outcomes

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

CO1: Recall and compile fundamental concepts, tools, theories, and models of geoinformatics necessary for formulating research questions.

CO2: Demonstrate a comprehensive understanding of geoinformatics methods and their relevance to solving complex real-world spatial problems..

CO3: Apply appropriate geoinformatics tools and techniques to design and conduct a structured research project.

CO4: Analyze geospatial datasets and project requirements to identify challenges and propose viable solutions within the internship context.

CO5: Evaluate existing literature, methodologies, and data quality to identify research gaps and justify the research approach.

CO6: Construct a well-structured dissertation report, including objectives, database, methodologies, results, discussion, limitation, future scope, and conclusion, adhering to academic and industrial standards.

Course Content

Dissertation (180 Hours)

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

- 1) Each Examinee shall prepare a Dissertation Paper individually under the supervision of a Departmental Faculty on his / her own chosen Theme.
- 2) The Report must be documented in triplicate (1 = examinee, 2 = seminar library, 3 = supervisor) under the following Heads – *Introduction & Conceptual Background; Statement of the Problem; Objectives of Study; Literature Review; Methodology including data / information / map collection; Location of the Study Area; Analysis, Display and Interpretation of Data (relating to each Objective separately); and Conclusion.*
- 3) The Dissertation Paper should contain *Acknowledgement, Preface, Table of Content, List of Tables,*

- 4) *List of Figures, List of Photographs, List of References, Appendix, and Bibliography/Reference.*
- 5) Pages containing Illustrations (Sketches, Graphs, Diagrams, Maps, Photographs, etc.) = 25
- 6) (maximum).
- 7) Word Limit = 8000 (maximum) excluding Tables and Appendix (Computer typed, Line Spacing
- 8) = 1½, Arial Narrow / Times New Roman / Helvetica 10 / 11 / 12).
- 9) Each Examinee shall submit a copy of the Report before the actual day of Examination (to be
- 10) announced by the convener each year).
- 11) Each Examinee shall present his / her Paper before an audience comprising Internal / External
- 12) Examiners and others on the day of Examination using OHP or LCD Projector (maximum 25 slides about —
- 13) *concept / idea / theme; major objectives; methodology; study area; observations and analysis; conclusion).*
- 14) Time allotted for each presentation = 20 minutes (maximum).
- 15) Marks on Report and Presentation shall be separately awarded by the Internal and External
- 16) Examiners and then averaged.

Recommended Readings:

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

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

| | | | | | |
|--------------------------------|--------------------------------------|----------|----------|----------|----------|
| GEO559 | Field Project | L | T | P | C |
| Version 1.0 | | | | | 4 |
| Pre-requisites/Exposure | Undergraduate knowledge of Geography | | | | |
| Co-requisites | - | | | | |

Course Outcomes

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

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

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

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

Course Content

Field Report (90 Hours)

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

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

- Marks on Report shall be awarded by the Internal Examiners and on Viva Voce by the External Examiners and then added together.

Recommended Readings:

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