Program Curriculum

Bachelor of Science (BS)
Remote Sensing and
GIS

Department of Agricultural Engineering
FAS&T, Bahauddin Zakariya University
Multan

Associate Degree in Remote Sensing and GIS
BS Remote Sensing and GIS

Background and Justification

Advancements in scientific and engineering knowledge have led to the emergence of modern tools such as Geographic Information Systems (GIS), Remote Sensing (RS), simulation models, artificial intelligence, and high-efficiency irrigation systems. Remote Sensing has become a rapidly growing and highly demanded field, playing a critical role in national and international technological advancements.

Remote Sensing applications are inherently interdisciplinary, addressing complex challenges across various domains. The integration of remotely sensed data enables scientists and professionals to conduct advanced analyses, develop innovative solutions, and support decision-making through optimized techniques and modern datasets. These technologies are essential for the efficient management and protection of natural resources, including water, land, and the environment.

Recognizing the increasing significance of geospatial technologies, the Department of Agricultural Engineering at the Faculty of Agricultural Sciences & Technology (FAS&T), Bahauddin Zakariya University (BZU), is introducing the Bachelor of Science (BS) in Remote Sensing and GIS. Graduates of this program will be well-equipped to pursue careers in geospatial technology firms, mapping and surveying companies, research institutions, consulting firms, and government agencies. Additionally, they will contribute to applied technologies in both the public and private sectors, enhancing their expertise in remote sensing techniques and geospatial analysis.

Objectives of the Degree Program

- The BS Remote Sensing and GIS aims to:
- Provide education, training, and research opportunities in Remote Sensing and its allied disciplines, focusing on practical applications.
- Raise awareness among scientists, policymakers, administrators, and the public about the socio-economic benefits of Remote Sensing and its applications.
- Offer consultancy and technical expertise to support geospatial analysis and decision-making.
- Develop innovative Remote Sensing applications that contribute to advancements in the geospatial industry.
- Establish and maintain structured databases using satellite imagery for temporal analysis across various disciplines, making geospatial information accessible to both public and private sectors.
- Design and implement decision support tools such as early warning systems and long-term monitoring frameworks.
- Conduct research and projects on critical topics such as land-use/land-cover changes, climate change, and their implications across different applied domains.

Course Learning Outcomes

Course learning outcomes (CLOs) are the bare minimum standards of learning that students must achieve upon completing a specific course. These outcomes serve as essential benchmarks, ensuring consistency in the quality of education across institutions. The CLOs prescribed herein represent the minimum level of competency and understanding expected from students. While these standards must not be compromised, departments are encouraged to enhance the rigor of the CLOs by incorporating additional learning outcomes, provided these do not alter the essence of the prescribed standards. In this policy, CLOs are exclusively developed for major field courses within the program. For interdisciplinary courses, departments offering these courses are responsible for developing their CLOs in alignment with their respective disciplines and program requirements. Moreover, CLOs for elective courses are not prescribed here, as these are advanced or specialized courses. The development of CLOs for electives is the responsibility of the respective departments, taking into account the course's advanced nature and relevance to the program. For general education courses as required under the HEC Undergraduate Education Policy V 1.1., departments may adopt the CLOs prescribed in the HEC-developed model courses.

Requirement of Field Experience / Internship

It is a mandatory degree award requirement of three (03) credit hours for BS Remote Sensing and GIS. Internship of six (06) to eight (08) weeks (preferably undertaken during semester or summer break) must be graded by a faculty member in collaboration with the supervisor in the field. This requirement cannot be substituted with additional course work, capstone or project work.

Requirement of Capstone Project

It is a mandatory degree award requirement of three (03) credit hours for BS Remote Sensing and GIS. A capstone project is multifaceted body of work that serves as a culminating academic and intellectual experience for students. The capstone project must be supervised and graded by a faculty member as per the protocols prescribed by the concerned department. This requirement cannot be substituted with additional course work or internship.

Associate Degree in Remote Sensing and GIS

The first-four semesters of the BS Remote Sensing and GIS as prescribed in this policy are aligned with the structure of Associate Degree Program in Remote Sensing and GIS. Capstone Project and Field experience is not a mandatory requirement for the Associate Degree in Remote Sensing and GIS.

Entry and Exit Provisions at Undergraduate Level

a. Pathway for Graduates with Associate Degree

- Students having completed Associate Degree in Remote Sensing and GIS or related disciplines are allowed admission in the fifth semester of the BS Remote Sensing and GIS.
- Students having completed Associate Degree in disciplines other than Remote Sensing and GIS and related disciplines may be offered deficiency courses from 15-18 credits through bridging semester prior to enrollment in 5th Semester of BS Remote Sensing and GIS Program. The bridging courses shall be determined by the concerned admitting department.
- The minimum eligibility for admission in the fifth semester in above cases is 2.00/4.00 CGPA in the prior qualification i.e., Associate Degree. The concerned university may, however, set higher eligibility and admission criteria for admission in the fifth semester of BS in Remote Sensing and GIS.

b. Pathway for Graduates with Conventional BSc/Equivalent Degree Programs

- Students having completed two-year conventional BSc/equivalent degree programs are allowed admission in the fifth semester of BS Remote Sensing and GIS in which case, such students shall be required to complete deficiency courses from 15-18 credit hours through bridging semester. The bridging courses shall be determined by the concerned admitting department.
- The minimum eligibility for admission in the fifth semester in this case is 45% cumulative score in the prior qualification i.e., two-year conventional BSc/equivalent degree programs. The concerned university may however set higher eligibility and admission criteria for admission in the fifth semester of BS Remote Sensing and GIS.

c. Exiting from BS in Remote Sensing and GIS with the Associate Degree

- Students enrolled in BS Remote Sensing and GIS are allowed to exit the program with Associate Degree in Remote Sensing and GIS provided that they have completed the requirements of the first-four semesters of the BS Remote Sensing and GIS.

Program Learning Outcomes

By the end of a degree in BS Remote Sensing and GIS, a graduate shall be able to

- Demonstrate proficiency in using remote sensing technologies, geospatial techniques, and related tools to collect, analyze, and interpret spatial and non-spatial data.
- Process and visualize geospatial data, enabling informed decision-making and problem-solving for real-world problems in fields such as urban planning, environmental management, and disaster response etc.
- Effectively communicate complex geospatial concepts, analyses, and findings to diverse audiences through written reports, visual presentations, and oral communication.

- Demonstrate a commitment to lifelong learning and professional development by engaging in ongoing education, staying informed about technological advancements and best practices in the fields of remote sensing and GIS.
- Conduct independent research using remote sensing and GIS methodologies, demonstrating critical thinking, data collection, analysis, and report writing skills.

Eligibility:

1. Intermediate (Pre-engineering, Pre-medical, and ICS)/A-levels (involving 12 years of schooling) or an IBCC equivalent qualification
2. For candidates without mathematics, the admitting university shall conduct a mandatory admission test to find their suitability for admission purpose.

Duration:

- Four-year program spread over 8 semesters (two Semesters per Year) and 136 credit hour courses including final project.
- The student may Exit with Associate Degree in Remote Sensing and GIS after completion of 04 Semesters in Remote Sensing and GIS four year degree program.

Program Structure

Minimum Credit Hours	136
General Education Courses	32 credit hours (13 courses)
Discipline Related Courses / Major	86 credit hours (29 courses)
	Major Compulsory Courses: 68 Credits (23 Courses)
	Major Electives: 18 Credits (06 Courses)
Interdisciplinary/ Allied Courses	12 credit hours (4 courses)
Field Experience/Internship	3 credit hours
Capstone Project	3 credit hours
Program Duration	Minimum: 4 Years Maximum: 6 Years (Further extendable to another year subject to the approval of the university's statutory body following the provisions of HEC Undergraduate Education Policy 2023 V 1.1)
Semester Duration	16-18 weeks for regular semesters (1-2 weeks for examination) 8-9 weeks for summer semesters (1 week for examination)

Course Load (per semester)	15-18 credit hours for regular semesters Up to 8 credit hours for summer semesters (For remedial/deficiency/failure/repetition courses only)
3 Credit Hours (Theory)	3 classes (1 hour each) OR 2 classes (1.5 hours each) OR 1 class (3 hours) per week throughout the semester.
1 Credit Hours (Practical Work)*	1 Credit hour of practical work requires three contact hours per week throughout the semester.
Policy for Probation in Semester	i. The students acquiring less than 2.00/4.00 GPA in a semester but passing in all papers will be promoted with the condition to achieve more than 2.0 GPA in the next semester and s/he will be put on probation for the next semester. ii. The students acquiring GPA 1.7 and above but failing in any paper(s) will be placed on probation and promoted to the next semester conditionally. They will have to be registered for summer semester to improve the grade. iii. Students acquiring GPA less than 1.7 in two consecutive semesters and failing in any paper(s) even after attending summer semester for one academic year will be dropped from university rolls.

Degree Requirement:

- Minimum 136 Credits are required to complete BS Remote Sensing and GIS
- Minimum Cumulative Grade Point Average (CGPA) required is 2.0 out of maximum of 4.0 CGPA.

Scheme of Studies

The standard scheme of studies for BS in Remote Sensing and GIS is given as under:

SEMESTER I				
Code	**S. No**	**COURSE**	**CREDIT HOURS**	**CATEGORY**
MAT-101	1	Calculus and Analytical Geometry	3 (3-0)	General Education
ENG-101	2	Functional English	3 (3-0)	General Education
CSC-101	3	Information and Communication Technologies (ICT)	3 (2-1)	General Education
RGS-101	4	Introduction to GIS	3 (2-1)	Major
RGS-102	5	Introduction to Physical Geography	3 (3-0)	Major
CSC-102	6	Introduction to Programming (IDS-I)	3 (2-1)	Interdisciplinary
	7	Basic Mathematics (For the students having **pre-medical** background)		
ARAB-151		Translation of the Holy Quran I		
	Total Credits (18)			

SEMESTER II				
Code	**S. No**	**COURSE**	**CREDIT HOURS**	**CATEGORY**
MAT-102	1	Linear Algebra	3 (3-0)	General Education
SSH-101	2	Introduction to Economics	2 (2-0)	General Education
ENG-102	3	Technical Writing and Presentation Skills	3 (3-0)	General Education
PHY-102	4	Applied Physics	3 (2-1)	General Education
RGS-103	5	Introduction to Remote Sensing	3 (2-1)	Major
RGS-104	6	Map work and Projections	3 (2-1)	Major
ARAB-152		Translation of the Holy Quran II		
	Total Credits (17)			

SEMESTER III				
Code	**S. No**	**COURSE**	**CREDIT HOURS**	**CATEGORY**
	1	Functional Language	2 (2-0)	General Education
ISL-201	2	Islamic Studies and Ethics	2 (2-0)	General Education
SSH-201	3	Pakistan Studies	2 (2-0)	General Education
RGS-201	4	Land Surveying	3 (2-1)	Major
RGS-202	5	Digital Image Processing	3 (2-1)	Major
RGS-203	6	Global Navigation Satellite System	3 (2-1)	Major
IDS-201	7	Introduction to Earth Sciences	3 (3-0)	Interdisciplinary
ARAB-251		Translation of the Holy Quran III		
	Total Credits (18)			

SEMESTER IV				
Code	**S. No**	**COURSE**	**CREDIT HOURS**	**CATEGORY**
SSH-202	1	Civics and Community Engagement	2 (2-0)	General Education
SSH-203	2	Ideology and Constitution of Pakistan	2 (2-0)	General Education
MSC-201	3	Entrepreneurship	2 (2-0)	General Education
RGS-204	4	Active Remote Sensing	3 (2-1)	Major
RGS-205	5	Photogrammetry	3 (2-1)	Major
RGS-206	6	Digital Cartography	2 (1-1)	Major
RGS-207	7	Spatial Data Analysis	3 (2-1)	Major
ARAB-252		Translation of the Holy Quran IV		
	Total Credits (17)			

SEMESTER V				
Code	**S. No**	**COURSE**	**CREDIT HOURS**	**CATEGORY**

IDS-301	1	Introduction to City and Regional Planning (IDS-III)	3 (3-0)	Interdisciplinary
IDS-302	2	Precision Agriculture (IDS-IV)	3 (3-0)	Interdisciplinary
RGS-301	3	Spatial Data Infrastructure and Standardization	3 (3-0)	Major
RGS-302	4	Mobile Data Acquisition and Mapping	3 (2-1)	Major
RGS-303	5	GIS Programming and Customization	3 (2-1)	Major
ARAB-351		Translation of the Holy Quran V		
	Total Credits (15)			

SEMESTER VI				
Code	**S. No**	**COURSE**	**CREDIT HOURS**	**CATEGORY**
RGS-304	1	Research Methodology	3 (3-0)	Major
RGS-305	2	Spatial Decision Support Systems	3 (3-0)	Major
RGS-306	3	Spatial Databases	3 (2-1)	Major
RGS-307	4	Hyperspectral Remote Sensing	3 (2-1)	Major
	5	Elective-I	3 (3-0)	Major
	6	Elective-II	3 (3-0)	Major
ARAB-352		Translation of the Holy Quran VI		
	Total Credits (18)			

SEMESTER VII				
Code	**S. No**	**COURSE**	**CREDIT HOURS**	**CATEGORY**
RGS-401	1	Web GIS	3 (2-1)	Major
RGS-402	2	Artificial Intelligence in RS and GIS	3 (2-1)	Major
RGS-403	3	Spatial Data Modelling	3 (2-1)	Major
	4	Elective-III	3 (3-0)	Major
	5	Elective-IV	3 (3-0)	Major
ARAB-451		Translation of the Holy Quran VII		
	Total Credits (15)			

SEMESTER VIII				
Code	**S. No**	**COURSE**	**CREDIT HOURS**	**CATEGORY**
RGS-404	1	Unmanned Aerial Vehicle and Data Processing	3 (2-1)	Major
RGS-405	2	Machine Learning in Spatial Data	3 (2-1)	Major
	3	Elective-V	3 (3-0)	Major
	4	Elective-VI	3 (3-0)	Major
CAP-401	5	Capstone Project	3 (3-0)	Capstone Project
ARAB-452		Translation of the Holy Quran VIII		
	Total Credits (15)			

Recommended list of interdisciplinary courses:

Student may opt interdisciplinary courses from the following list where required in the scheme of studies for BS in Remote Sensing and GIS, to complement their holistic understanding of the major, provided that the same is allowed by the admitting department. The list provided here is a recommended one only, and the offering department may add more courses as and when needed, provided that the same is approved by the university's relevant statutory body.

1. Geography of Pakistan

2. Introduction to Human Geography
3. Introduction to Programming
4. Data Structure and Algorithms
5. Introduction to Environmental Science
6. Geology
7. Geomorphology
8. Meteorology
9. Climatology
10. Economics and Sustainable Development
11. Disaster Management and Risk Assessment
12. Project Management

SPECIALIZATIONS IN BS REMOTE SENSING AND GIS:

1. Natural Resource Management (Any 06 Electives)

i. Introduction of GIS in Natural Resources Management
ii. Spatial Data Analysis for Natural Resources
iii. GIS for Forest and Biodiversity Conservation
iv. GIS for Watershed and Water Resources Management
v. Land Use and Land Cover Change Analysis
vi. GIS for Soil Resource Mapping and Sustainable Land Management
vii. GIS in Climate Change Impact Assessment
viii. GIS in Mineral Exploration
ix. GIS for Hydrocarbon Exploration

2. Urban and Regional Planning (Any 06 Electives)

i. Urban and Regional Planning
ii. Land Use Planning and Zoning Regulations

iii. Geospatial Analysis for Urban Planning

iv. Sustainable Cities and Environmental Planning

v. Transportation Planning and Infrastructure Development

vi. Urban Economics and Policy Analysis

vii. Community Engagement and Participatory Planning

viii. Resilient Cities and Disaster Risk Management

ix. Infrastructure Planning

xi. Computer-aided drawing (CAD)

3. Science of Climate Change (Any 06 Electives)

i. Fundamentals of Climate Science and Global Change

ii. Climate Change Monitoring with Remote Sensing

iii. Climate Modeling and Future Projections

iv. GIS for Climate Risk and Vulnerability Assessment

v. Remote Sensing of Atmospheric Changes and Air Pollution

vi. Water Resource Management and Climate Change

vii. Land Use and Land Cover Change in a Changing Climate

viii. Coastal and Oceanic Climate Change Impacts

ix. Climate Change Policy, Adaptation, and Mitigation Strategies

x. Geospatial Techniques for Disaster Risk Reduction and Climate Resilience

4. Spatial Data Science (Any 06 Electives)

i. Introduction to Spatial Data Science

ii. Spatial Data Visualization

iii. Geospatial Data Acquisition and Management

iv. Spatial Statistics and Geospatial Modeling

v. Big Data and Cloud Computing (GEE) for Spatial Analysis

vi. Machine Learning for Spatial Data

vii. Geospatial Time Series Analysis

viii. Advanced Remote Sensing Data Analysis

ix. Spatial Network Analysis and Modeling

x. Geospatial Data Science for Urban Analytics

5. Spatial Business Intelligence (Any 06 Electives)

i. Geospatial Business Intelligence and Decision Support Systems

ii. Location Intelligence and Market Analysis

iii. Supply Chain Optimization and Logistics GIS

iv. Smart Cities and Urban Business Analytics

v. Geospatial Financial and Risk Analytics

vi. Social Media and Geospatial Business Trends

vii. Artificial Intelligence and Machine Learning in Business GIS

viii. GIS for Retail and Real Estate Market Intelligence

ix. Cloud Computing and Mobile GIS for Business Applications

x. Capstone in Geospatial Intelligence

6. Disaster Risk Management (Any 06 Electives)

i. Disaster Risk Management and GIS

ii. Remote Sensing for Hazard Assessment and Monitoring

iii. Geospatial Technologies for Disaster Preparedness and Early Warning Systems

iv. Spatial Data Analysis for Risk and Vulnerability Mapping

v. Drone and Satellite Applications in Disaster Response and Recovery

vi. Multi-Hazard Risk Assessment Using GIS and Remote Sensing

vii. Big Data and AI for Disaster Prediction and Impact Analysis

viii. Geospatial Decision Support Systems for Emergency Management

ix. Climate Change and Disaster Resilience Planning with GIS

7. Precision Agriculture (Any 06 Electives)

i. Introduction to GIS in Agriculture

ii. Precision Agriculture and Geospatial Technologies

iii. Soil Fertility Mapping and Land Suitability Analysis

iv. Remote Sensing for Crop Monitoring

v. Climate and Weather Analysis for Agriculture

vi. Irrigation Management and Water Resource Mapping

vii. Pest and Disease Monitoring and Mapping

viii. Smart Farming and IoT-Enabled GIS Applications

ix. Variable Rate Technology

xi. Application of RS & GIS in Agricultural Engineering

8. Geospatial App Development (Any 06 Electives)

i. Introduction to GIS Programming and Automation

ii. Spatial Databases and Geodatabase Management

iii. Geospatial Analysis and Automation

iv. API Development for Web Mapping

v. Mobile GIS and Location-Based Services Development

vi. 3D GIS and Augmented Reality Applications

vii. Full-Stack GIS Application Development

viii. Advanced Web Mapping Technologies

SEMESTER I				
Code	**S. No**	**COURSE**	**CREDIT HOURS**	**CATEGORY**
MAT-101	1	Calculus and Analytical Geometry	3 (3-0)	General Education
ENG-101	2	Functional English	3 (3-0)	General Education
CSC-101	3	Information and Communication Technologies (ICT)	3 (2-1)	General Education
RGS-101	4	Introduction to GIS	3 (2-1)	Major
RGS-102	5	Introduction to Physical Geography	3 (3-0)	Major
CSC-102	6	Introduction to Programming (IDS-I)	3 (2-1)	Interdisciplinary
	7	Basic Mathematics (For the students having **pre-medical** background)		
	Total Credits (18)			

Code	**Calculus and Analytical Geometry**	**Credit Hours**
MAT-101		**3(3-0)**

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- apply the differentiation integration in solving analytical problems
- demonstrate the use of acquired knowledge to solve problems of practical nature

Course Outline

- Analytical Geometry
- Review of vectors, scalars and vector products.
- Three-dimensional coordinate system and equation of straight line and plane Functions Limit and Continuity
- Review of functions and graphs, Limits & Continuity, Techniques of Finding Limits,
- Discontinuity, Limits of Sine and Cosine and Exponential Functions Differentiation: a. Introduction to Derivatives b. Examples of Derivatives , Derivative as Rate of Change, Derivative's Rules e. Implicit Differentiation f. Higher order derivatives g. Leibnitz Theorem

- Applications of Derivatives: applications of Derivatives, Monotonic functions, Optimization problems, Relative and Absolute extrema, First and second derivative tests, Point of inflection, Concavity, Curvature, Indeterminate Forms and L' Hospital rule
- Differentials Integration: a. Integrals and Properties of Integrals b. Techniques of Integration c. Integration by Parts d. Definite Integrals e. Integration of Trigonometric f. Exponential and Inverse Functions g. Integration by Partial Fractions h. Reduction Rules
- Applications of Integration: a. Applications of Integration b. Area under the curve c. Area between curves d. Solids of Revolution e. Volume of Solids of revolution by disk, washer, cylindrical shell & Cross Section Methods g. Center of Pressure and Depth of Center of Pressure, Center of Mass
- Arc length Improper Integrals a. Improper Integral b. Integrals and Singularities c. Convergence of improper integrals Infinite Sequence and Series: a. Sequence and Infinite Series b. Convergence and Divergence of sequences and series c. Positive Term Series d. Integral Test e. Basic Comparison Test f. Limit Comparison Test g. Ratio and Root tests h. Alternating series i. Absolute and Conditional Convergence, Power and Taylor Series: k. a. Power series b. Maclaurin and Taylor Series and its Applications

Recommended Books

- Thomas' Calculus by George B. Thomas, Jr., Maurice D. Weir, Joel R. Hass, Pearson, USA.
- Swokowski, Onlinick & Pence: Calculus
- Robert T. Smith & Roland B. Minton: Calculus
- Calculus: Early Transcendentals by James Stewart. Brooks/Cole USA

Code	Functional English	Credit Hours
ENG-101		3(3-0)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- know English correctly in speaking and writing skills.
- apply different writing and active reading strategies to comprehend texts.
- interpret and translate the vocabulary and skills to use English in professional life.

Course Outline

- Public Speaking, The Art of Creating a Power Point Presentation.
- Interacting with the Opposite Gender, Classroom Etiquettes and Teachers' Expectations
- Articles, Prepositions.
- Homophones, Punctuation
- Tenses in English Grammar, Formal Letter Writing
- Summary writing
- Organizing and planning your writing
- Sensory Perception in writing.
- Critical thinking

- Final Term Project

Recommended Books

- P. C. Wren & H. Martin "High School English Grammar & Composition".
- Colin W. Davis & Andrew J. Watts New Expressway For English 1 (New Edition)
- Hert A. Murphy & Herbert William Hildebrandt. Effective Business Communications
- Diana Hacker. A Writer's Reference
- Sadat Ali Shah. Exploring The World Of English
- J. Thomson and A. V. Martinet. Practical English Grammar, "University Physics", 13th Edition.

Code	Information and Communication Technologies	Credit Hours
CSC-101		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- describe the basic computer system, its operation and applications in various fields especially in education and engineering disciplines.
- describe the data processing and data security in computer, internet and web applications and networking concepts and database management.
- follow instructions and perform the embedded systems with applications and programming languages to use for system developments and problem solving.

Course Outline

- Introducing Computer Systems: Basic Definitions
- Computer and Communication Technology
- The applications of ICT - particularly for Engineers Basic operations and components of a generic computer system
- Basic operations: Input, Processing, Output, Storage Basic components: Hardware, Software, Data, Users
- Types of storage devices Processing Data
- Transforming data into information
- How computers represent and process data
- Processing Devices, CPU architecture
- The Internet, The Internet and the World Wide Web- browsers, HTML, URLs/ How DNS works
- Email and other programs Introduction to Embedded Systems
- What is an Embedded System, Applications, Components
- Programming Languages, Popular Development Platforms, Networking Basics, Uses of networks, Common types of networks (LAN, WAN, MAN etc.)
- Introduction to OSI Model

- Future of Networks, Database Management, Hierarchy of Data, Maintaining Data
- Database Management Systems, Exposure to ICT Tools and Blogs (Student Assignment) Protecting your privacy, your computer and your data
- Basic Security Concepts, Threats to users, Threats to hardware, Threats to Data, ICT in Education Future Trends in ICT

Practical
Final Presentations Tools / Software Requirement Microsoft Office, Windows, Virtual Box, NetBeans

Recommended Books
- "Introduction to Computers", Peter Norton, 7th Edition, 2013, McGraw-Hill.
- "Computing Essentials", Timothy O'Leary and Linda O'Leary, 2010, McGraw-Hill.
- Using Information Technology: A Practical Introduction to Computers & Communications", Williams Sawyer, 6th Edition, 2005, McGraw-Hill.
- "Discovering Computers, Complete: Your Interactive Guide to the Digital World. Cengage Learning" Shelly GB, Vermaat ME, 2012 Ed.

Code	Introduction to Geographic Information Systems	Credit Hours
RGS-101		3 (2-1)

Learning Outcomes
Upon successful completion of the course, the student will be able to:
- Understand terminologies, and scope of GIS
- Know the techniques of data capturing, storing, basic analysis, and retrieval in map and report formats
- Evaluate quality parameters of existing GIS data
- Analyze GIS data for problems identification
- Applying GIS applications for development plan implementation and monitoring

Course Outline
- Introduction, Definitions Components, Functional Subsystem, Raster Data Model, Vector Data Model, Attribute Data Model
- Data Acquisition Techniques, Data Resources, Data Capturing Techniques And Procedures
- Data Interoperability (Transferring Data to and From Different Software like ArcGIS, AutoCAD etc.)
- Remote Sensing as Data Source; Introduction to Remote Sensing and Image Processing
- Data Transformation, Visualization of Spatial Data in Desired Projections
- Cartography and Visualization: Map Elements, Symbols to Portray Points, Lines, Area and Volumes, Variables Visual Hierarchy, Map Scale And Spatial Details

- Introduction to Spatial Analysis: Overlay Functions, Neighborhood Functions, Triangular Irregular Network (TIN), Digital Elevation Model (DEM)
- Network And Overlay Analysis, Segmentation Analysis
- Spatial Data Quality, Data Accuracy and Precision

Practical:

- Introduction to GIS lab (hardware/software)
- Practical demonstration of raster/vector/attribute data preparation, entry and display
- Data capturing through various means
- Digitization, vector/raster conversion, data layer integrations, data visualization, map

Recommended Books

- Heywood, I., Cornelius, S. and Carver, S. (2006), An introduction to Geographic Information System, New York, Addison Wesley Longman.
- Clarke, K. (2004), Getting Started with Geographic Information System, New York, Prentice Hall, ISBN – 1879102897.
- Burrough, P., (2002), Principles of Geographic Information Systems for Land Resources Management, Oxford, Oxford University Press, ISBN – 0198233655.
- Lo, C. P. and Yeung, A. K. W. (2002), Concepts and Techniques of Geographic Information Systems. Upper Saddle River, NJ, Prentice Hall.
- Otto Huisman and Rolf A. de (2000), Principles of Geographic Information Systems, The Netherlands ITC, ISSN-978-90-6164- 269-5.
- ESRI, Getting Started with ArcGIS, Online Tutorial, USA.

Code	Introduction to Physical Geography	Credit Hours
RGS-102		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Define and describe the four spheres of the earth
- Understand and apprehend the physical processes occurring on the earth.
- Evaluate the importance of physical Geography in natural resource management

Course Outline

- Definition, scope, and major branches
- Lithosphere
- Plate tectonics, mountain building forces
- Internal structure of earth

- Rocks–origin, formation and types: Igneous, Sedimentary and Metamorphic Rocks
- Geomorphic processes: Terrestrial and extra-terrestrial processes
- An overview of the Geomorphic agents and there Landforms
- Atmosphere
- Composition and structure of Atmosphere
- Atmospheric temperature and pressure,
- Global circulation and wind systems
- Cyclones and other Atmospheric disturbances
- Atmospheric moisture and precipitation
- Air masses and fronts
- Hydrosphere
- Hydrological cycle
- Ocean composition, morphology
- Temperature, salinity and other characteristics of ocean water
- Movements of the ocean water; waves, currents and tides
- Biosphere
- Eco-systems
- Formation and types of soils

Practical:

- Study and identification of landforms using Satellite imageries and Topographic Sheets.
- Observation and recording of weather data from a weather station.
- Isotherms, isobars, climographs, meteorological instruments, study of weather maps.
- Construction of maps and diagrams, identification of rocks and minerals, methods of showing relief: contours (pattern, cross section).

Recommended Books

- Peterson, J. F., Sack, D. & Gabler, R. E. (2011). Physical Geography, Brooks Cole.
- Scott, R. C. (1996). Introduction to Physical Geography, West Publishing Co, New York.
- Small, R. J. (1989). Geomorphology and Hydrology, Longman, London.
- Strahler, A. (2013). Introduction to Physical Geography, John Wiley & Sons, New Jersey.
- Strahlar, A. N., Strahlar, A. H. (2004). Physical Environment, John Wiley, New York.
- Stringer, E. T. (2004). Modern Physical Geography, John Wiley, New York.
- Thornbury, W. D. (2004). Principles of Geomorphology, John Willy & Sons, New York.
- Thurman, H. V. & Trujillo, A. P. (2013). Essentials of Oceanography, Prentice-Hall, Inc, New York.
- Tarbuck, J.E and Lutgens, K.F. 2000. Earth Science, 9 Editions, Prentice Hall: New Jersey.

Code	Introduction to Programming	Credit Hours

CSC-102		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Write, compile and debug programs in C language.
- Use different data types in a computer program.
- Design programs involving decision structures, loops, arrays and functions.
- Identify the difference between call by value and call by reference
- Use pointers to understand the dynamics of memory
- Create and perform different file operations.

Course Outline

- Introduction to the C Language – Algorithm, Pseudo code, Flow chart, Background, C Programs, Identifiers, Data Types, Variables, Constants, Input / Output, Operators (Arithmetic, relational, logical, bitwise etc.), Expressions, Precedence and Associatively, Expression Evaluation, Type conversions.
- Statements- Selection Statements (making decisions) – if and switch statements, Repetition statements (loops)-while, for, do-while statements, Loop examples, other statements related to looping – break, continue, go to, Simple C Program examples.
- Functions- Introduction to Structured Programming, Functions- basics, user defined functions, inter function communication (call by value, call by reference), Standard functions.
- Storage classes-auto, register, static, extern, scope rules, arrays to functions, recursive functions, example C programs.
- Arrays– Basic concepts, one-dimensional arrays, two – dimensional arrays, multidimensional arrays, C programming examples
- Pointers – Introduction (Basic Concepts), pointers to pointers, compatibility, Pointer Applications, Arrays and Pointers, Pointer Arithmetic, memory allocation functions, array of pointers, pointers to void, pointers to functions, command –line arguments, Introduction to structures and unions.
- Strings – Concepts, C Strings, String Input / Output functions, string manipulation functions, string
  /Data conversion.
- Input and Output – Concept of a file, streams, text files and binary files, Differences between text and binary files, State of a file, Opening and Closing files, file input / output functions (standard library input / output functions for files), file status functions (error handling), Positioning functions.

Practical:

- given real-world problems to solve using programming, requiring them to break down complex tasks into smaller, manageable steps.
- Practical exercises often involve implementing common algorithms (e.g., sorting, searching, graph traversal) in code.

- learn to work with various data structures (e.g., arrays, linked lists, trees, graphs) and implement them in code.
- Practical projects may involve designing, implementing, testing, and debugging software applications.

Recommended Books

- Computer Science: A Structured Programming Approach Using C, B.A.Forouzan and R.F. Gilberg, Third Edition, Cengage Learning.
- The C Programming Language by Brian Kernighan and Dennis Ritchie 2nd edition
- Absolute beginner's guide to C, Greg M. Perry, Edition 2, Publisher: Sams Pub., 1994.
- Computer Programming and Data Structures by E Balagurusamy, Tata McGraw Hill.

SEMESTER II				
Code	**S. No**	**COURSE**	**CREDIT HOURS**	**CATEGORY**
MAT-102	1	Linear Algebra	3 (3-0)	General Education
SSH-101	2	Introduction to Economics	2 (2-0)	General Education
ENG-102	3	Technical Writing and Presentation Skills	3 (3-0)	General Education
PHY-102	4	Applied Physics	3 (2-1)	General Education
RGS-103	5	Introduction to Remote Sensing	3 (2-1)	Major
RGS-104	6	Map work and Projections	3 (2-1)	Major
ARAB-152		Translation of the Holy Quran II		

Code	**Linear Algebra and Applications**	**Credit Hours**
MAT-102		**3 (3-0)**

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Geometry
- Matrices and Determinants

Course Outline

- Vectors
- Vector Spaces
- Matrices & Determinants
- Linear Transformations
- Operations on matrices
- Inner products
- Eigenvalues & Eigenvectors
- Applications to Systems of Equations and to Geometry

Recommended Books

- Lay, D.C. (2002). Linear Algebra, 3rd Ed., Amazon.
- Poole, D. (2003). Linear Algebra: A Modern Introduction, Amazon.
- Strang, G. (2003). Introduction to Linear Algebra, 3rd Edition, Amazon.
- Lipschutz, S., & Lipson, M. (2002). Schaum's Easy Outline of Linear Algebra,
- Williams, G. (2004). Linear Algebra, Fifth Edition, Amazon.

Code	Introduction to Economics	Credit Hours
SSH-101		2 (2-0)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Apply the appropriate engineering economics analysis method(s) for problem solving i.e. present worth, annual cost, rate of return, payback, break-even, benefit-cost ratio
- Evaluate the cost effectiveness of individual projects using the methods learnt, draw inferences for investment decisions, and compare the life cycle cost of multiple projects.
- Compute the depreciation of an asset using standard depreciation techniques to assess its impact on present or future value

Course Outline

- Economic decisions v/s design decisions, Large scale projects and types of strategic economic decisions
- Fundamental principles of economics, Interest: The Cost of Money, Economic Equivalence
- Development of Formulas for Equivalence Calculation, Unconventional Equivalence Calculations
- Nominal and Effective Interest Rates
- Equivalence Calculations with Effective Interest Rates and with Continuous Payments
- Changing Interest Rates, Debt Management, Investing in Financial Assets, Project Cash Flows
- Initial Project Screening Methods: payback Screening and Discounted Cash Flow Analysis
- Variations of Present-Worth Analysis, Comparing Mutually Exclusive Alternatives
- Capital Costs versus Operating Costs, Applying Annual-Worth Analysis, Life-Cycle Cost Analysis
- Design Economics, Rate of Return and Methods of Finding It, Internal Rate-of-Return Criterion
- Mutually Exclusive Alternatives, General Cost Terms; Classifying Costs for Financial Statements
- Cost Classifications for Predicting Cost Behavior, Future Costs for Business Decisions
- Estimating Profit from Production, Asset Depreciation: Economic versus Accounting
- Depletion, Income Tax Rate to be used in Economic Analysis, The Need for cash Flow in Engineering Economic Analysis, Cost-Benefit Estimation for Engineering Projects
- Developing Cash Flow Statements, Origins of Project Risk, Methods of Describing Project Risk: Sensitivity, Break-Even and Scenario Analysis
- Replacement Decisions, Capital Budgeting Decisions, Economic Analysis in the Service Sector

Recommended Books

- Contemporary Engineering Economics by Chan S. Park, 6th edition, Pearson 2015, ISBN: 9780134105598
- Engineering Economic Analysis by Donal G. Newnan, Jerome P. Lavelle, Ted G. Eschenbach, 12th edition, Oxford University Press, ISBN: 978-0199339273
- Engineering Economy by Leland T. Blank and Anthony Tarquin

Code	Technical Writing and Presentation Skills	Credit Hours
ENG-102		3 (3-0)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- develop good technical writing, language usage and reading skills.
- appreciate the importance of communication and developing understanding of communication concepts, principles, theories and problems.
- To develop good oral communication and presentation skills.

Course Outline

- Principles of writing good English, understanding the composition process: writing clearly; words, sentence and paragraphs.
- Comprehension and expression. Use of grammar and punctuation.
- Process of writing, observing, audience analyzing, collecting, composing, drafting and revising, persuasive writing, reading skills, listening skills and comprehension, skills for taking notes in class, skills for exams.
- Business communications; planning messages, writing concise but with impact.
- Letter formats, mechanics of business, letter writing, letters, memo and applications, summaries, proposals, writing resumes, styles and formats, oral communications, verbal and non-verbal communication, conducting meetings, small group communication, taking minutes.
- Presentation skills; presentation strategies, defining the objective, scope and audience of the presentation, material gathering material organization strategies, time management, opening and concluding, use of audio-visual aids, delivery and presentation.

Recommended Books

- *Business English* by Vawdrey, Stoddard and Bell

Code	Applied Physics	Credit Hours
PHY-102		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- define the basic terminologies related to applied physics
- explain the fundamental laws of physics relevant to the engineering sciences.
- implement knowledge of basic physical laws to solve various problems of applied nature
- demonstrate working principles of different science domains such as mechanics and thermodynamics using the laws of physics.

Course Outline

- Vectors: Review of vectors, Ordinary Differentiation of Vector, Gradient of Scalar field, Divergence and Curl of Vector Field. Line, surface and volume integrals with their applications.
- Mechanics: Newton Laws and their Applications(Simple Accelerometer, Banked Curve and Rotor), Frictional Forces and determination of Co-efficient of Friction, Work-Energy Theorem, applications of law of Conservation of Energy, Angular Momentum, Centre of Mass of two-particles, Many-particles and Solid Object.
- Thermodynamics: Laws of thermodynamics and Heat Transfer Mechanisms, Heat and Work, Kinetic Theory of gases, Ideal gases, Mean Free path, distribution of molecular speeds, Change in Entropy and Irreversible processes.
- Electricity & Magnetism: Electric field due to Discrete and Continuous Charge Distributions, Electrostatic Potential of discrete and Continuous charges, Gauss's Law and its Applications, Lorentz Force and Hall Effect, Ampere's Law, Magnetic Field due to current element (Circular Current Loop and Solenoid).
- Waves & Oscillations: Types of Waves and Superposition Principle, Wave Speed on a stretched string, Wave equation, Energy & Power of a Wave, Principle of Superposition and Standing Waves. Simple Harmonic oscillations. Forced & damp oscillations.
- Atomic and Nuclear Physics: Planck's explanations of Black Body Radiation, Photoelectric Effect, Compton Effect, De-Broglie Hypothesis, X-rays and Moseley's Law, Atomic Nucleus and Properties of Nucleus, Radioactive Decay and Radioactive Dating.
- Soil Physics: Thermal and Physical properties of Soil; Factor affecting; heat flow equations, Transport of gases and water vapors through soil, Transport of inert, non-adsorbing and adsorbing chemicals in soil, Volatile organic compounds transport in soil.

Practical:

- Construction of wiring systems fuses, switches of various types of insulators
- Circuits design and drawing of a typical farm electrical system.
- Selection of motor for various farm equipment such as forage cutters, feed-grinders, and shop tools.
- Practice on repair and adjustment of electric motors, switches, fuses, transmission wiring controls
- Study of 3 phase motor induction study
- Study of star and delta connections
- Study of semi-conductor, triode, diode valve and transistors.
- Use of AVO meter, CRO, planimeter
- Fabrication of full wave rectifier and inductive study of its wave-shape.
- Measurement of self-inductance and mutual inductance

Recommended Books

- Halliday, Resnick and Walker, "Fundamentals of Physics" 10th Edition Extended
- Hugh D. Young and R.A. Freedman, University Physics. 12th Edition

- Raymond A Serway and John W. Jawett, Jr. Physics for Scientists and Engineers with modern Physics, 09th Edition.
- G. B. Thomas, R. L. Finney, "Calculus and Analytic Geometry", 13th Edition.
- Hillel, D. 1998. Environmental Soil Physics. Elsevier Academic Press, San Diego, CA, USA.
- Hillel, D. 2004. Introduction to Environmental Soil Physics. Elsevier Academic Press, San Diego, CA, USA.

Code	Introduction to Remote Sensing	Credit Hours
RGS-103		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Understand the concepts of Remote sensing and its uses.

Course Outline

- History, Scope and Concept of Remote Sensing
- Elements of Remote Sensing
- Energy Sources or Illumination, Electromagnetic radiation its characteristics and different parts of spectrum
- Radiation and the Atmosphere
- Energy interaction with atmosphere
- Scattering and its types, Absorption
- Atmospheric Window
- Energy interaction with earth surface features
- Absorption, Transmission and Reflectance, Specular and Diffuse reflectance
- Spectral Reflectance Curves, Water, Vegetation and Soil Image Characteristics
- Recording of Energy by the Sensor Platforms (Types and Orbital Characteristics)
    1. Sensor types and their characteristics
    2. Image resolution types
    3. Swath width
- Data reception and processing
- Major components in digital image processing for radio metric correction
- Image Rectification and registration, Image Enhancement,
- Mosaicking and sub-setting, Interpretation and Analysis
- Visual Image Interpretation, Digital Image processing overview
- Applications Overview, Introduction to labs
- Overview of Image Processing Software (e.g. ERDAS Imagine, ENVI, Orfeo Toolbox), Image Georeferencing
- Layer stacking, Image Mosaicing,
- Extraction of AOI (Subsetting), Color composites,

- Various sensors data comparison, Image classification
- Unsupervised
- Supervised

Practical:

- given real-world problems to solve using programming, requiring them to break down complex tasks into smaller, manageable steps.
- Practical exercises often involve implementing common algorithms (e.g., sorting, searching, graph traversal) in code.
- learn to work with various data structures (e.g., arrays, linked lists, trees, graphs) and implement them in code.
- Practical projects may involve designing, implementing, testing, and debugging software applications.

Recommended Books

- Campbell, J. B. (2011). Introduction to Remote Sensing, 5th Ed. The Guilford Press.
- Foody, G.M. & Curran, P.J. (1994). Environmental Remote Sensing from Regional to Global scales. John, Wiley & Sons. Inc. 250 p.
- Gibson, P. J (2000). Introductory Remote Sensing: Principles and Concepts Rutledge.
- Lillesand, T. M. & Kiefer, R. W. (2010). Remote Sensing and Image Interpretation, 6th edition. John Wiley and Sons Inc.
- Lulla, K.&Dessinov, L.V. (2000). Dynamic Earth Environmental: Remote Sensing Observations from shuttle Mir Mission John, Wiley & Sons. Inc.288 p.
- Rancez, A.N. (1999). Remote Sensing for the Earth Sciences. John Wiley & Sons. Inc. 728 p.

Code	Map work and Projections	Credit Hours
RGS-104		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- have basic knowledge of portraying spatial features from reality by using cartographic techniques. Subject incorporates the fundamentals of map reading, map making.
- coordinate and projection systems, map symbolization and generalization.
- Map production and map classification techniques.

Course Outline

- Introduction to map work and projection
- Cartography,
- Nature of Cartography,

- Map Types.
- History of Cartography,
- Map Symbols,
- Lettering,
- Scale and direction,
- Coordinate systems,
- Map Projections,
- Graphical and datum,
- Map Projections,
- Mathematical,
- Perspective,
- non-perspective,
- conventional,
- Generalization,
- Thematic Maps,
- Descriptive Statistics,
- Class Intervals,
- Map Production.

Practical:

- Map reading
- Assignment on Types of Maps
- Understanding of survey of Pakistan symbology and Development of Charts
- Development of Graphical Map Projections
- Large to small scale map conversion
- Data classification and Thematic Mapping
- Map composite development
- Assignment on misleading cartography
- Visit to SOP

Recommended Books

- Slocum, Robert McMaster, Fritz Kessler, Hugh Howard (2004) "Thematic Cartography and Geographic Visualization", 2nd Edition, Terry. ISBN, 0130351237.
- Robert G. Cromley (2003) "Digital Cartography". Prentice Hall Inc.
- M.J. Kraak& F.J. Ormeling, (1996) "Cartography- Visualization of Spatial Data", Addison Wesley Longman Limited.
- Robinson, A.H., Morrison,J.L., Muhrcke, A.J.,Kimerling and Guptil,S.C. (1995) "Elements of Cartography" 6th edition, John Wiley & Sons, New York.

- Menno-Jan Kraak, FerjanOrmeling, “Cartography, Visualization of Spatial Data” (2002) 2nd Edition, ISBN 0130888907.
- AMAZON (1999) “Multimedia Cartography”, 1st Edition.

SEMESTER III				
Code	**S. No**	**COURSE**	**CREDIT HOURS**	**CATEGORY**
	1	Functional Language	2 (2-0)	General Education
ISL-201	2	Islamic Studies and Ethics	2 (2-0)	General Education
SSH-201	3	Pakistan Studies	2 (2-0)	General Education
RGS-201	4	Land Surveying	3 (2-1)	Major
RGS-202	5	Digital Image Processing	3 (2-1)	Major
RGS-203	6	Global Navigation Satellite System	3 (2-1)	Major
IDS-201	7	Introduction to Earth Sciences	3 (3-0)	Interdisciplinary
ARAB-251		Translation of the Holy Quran III		
	Total Credits (18)			

Code	**Islamic Studies / Ethics**	**Credit Hours**
ISL-201		**2 (2-0)**

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Fundamentals of Islam. (Aqaid, Ibadat, Islamic Dawah etc.)
- Ethical values of Islam
- Seerah of the Holy Prophet (PBUH)
- Islamic Civilization and its effects on humanity.
- Study of other prominent world religions and ethical systems in comparison with Islamic viewpoint.
- Multicultural societies.

Course Outline

- Fundamentals of Islam. (Aqaid, Ibadat, Islamic Dawah etc.)
- Ethical values of Islam
- Seerah of the Holy Prophet (PBUH)
- Islamic Civilization and its effects on humanity.
- Islamic Civilization and its effects on humanity.
- Study of other prominent world religions and ethical systems in comparison with Islamic viewpoint

- Study of other prominent world religions and ethical systems in comparison with Islamic viewpoint
- Multicultural societies.

Recommended Books

- Umari, S. Islam in the Light of a First Testament and Traditions
- 2. Hanif, Z. What Everyone Knows About Islam
- 3. Hamidullah, M. Introduction to Islam

Code	Pakistan Studies	Credit Hours
SSH-201		2 (2-0)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- To take an analytical view in the history and development of Muslim society and culture in the sub-continent, emergence of Pakistan and its constitutional development.
- To develop an appreciation of the issues and challenges currently being faced in Pakistan. The strengths of its people and strategies to deal with the impediments to progress. International relations of Pakistan.

Course Outline

- Historical background of Pakistan: Muslim society in Indo-Pakistan, the movement led by the societies, The downfall of Islamic society, The establishment of British Raj- Causes and consequences.
- Political evolution of Muslims in the twentieth century: Sir Syed Ahmad Khan; Muslim League; Nehru; AllamaIqbal: Independence Movement; Lahore Resolution; Creation of Pakistan and transfer of power.
- Pakistan culture and society, Constitutional and Administrative issues, Pakistan and its geo-political dimension, Pakistan and International Affairs, Pakistan and the challenges ahead.

Recommended Books

- The Emergence of Pakistan, by Chaudary M. Ali The Making of Pakistan, by K.K. Aziz.

Code	Map work and Projections	Credit Hours
RGS-201		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- have basic knowledge of portraying spatial features from reality by using cartographic techniques. Subject incorporates the fundamentals of map reading, map making.
- coordinate and projection systems, map symbolization and generalization.
- Map production and map classification techniques.

Course Outline

- Introduction to Surveying
- Surveying instruments.
  a. Chains, Tapes, Steel Bands, their Types and Uses
  b. Chain Surveying: Ranging and chaining of survey Lines.
  c. Fieldwork and plotting of chain survey.
- Compass Surveying: Prismatic Compass and Surveyor Compass, Uses, Bearing, Local Attraction, Fieldwork and Plotting
  a. Plane Table Surveying:
  b. Parts and Accessories,
  c. Methods of Surveying, Two Point and Three Point Problems
- Theodolite: Types and uses of Theodolites, Temporary and Permanent Adjustments, Measurement of Horizontal and Vertical angles
- Tacheometrical Surveying: Methods of Tachometric Surveying.
  a. Fieldwork and computations.
  b. Traversing: Traversing with Prismatic Compass, Theodolite and Plane Table,
  c. Computations and Adjustments of Traverse, Transformation of Co-ordinates
  d. Calculation of Areas and Volumes: Earth work calculation, D.M.D method, Simpson rule and Trapezoidal rule
- Total Station and GPS

Practical:

- Introduction to measuring instruments and practice on measurement of distances.
- Chain Surveying and plotting.
- Compass Traversing
- Plane Tabling by methods of radiations and intersections.
- Two Points Problem
- Three Points Problem
- Introduction to measuring instruments and practice on measurement of distances.
- Level adjustments by Two-Peg method.
- Profile and Cross-Sectioning

- • Theodolite Traversing

Recommended Books

- Brinker, A.C. and Taylor, W.C. 2002. Elementary Surveying. International Text Book Co. Scranton, Pennsylvania, USA.
- Ramsay, J.P. Wilson. 2000. Land Surveying. Macdonald and Evans Ltd. Estover, Plymouth PL 6 7PZ.
- Clark, David. 1989. Plane and Geodetic Surveying for Engineers Vol. I. Constable and Co. Ltd. London, England.

Code	Digital Image Processing	Credit Hours
RGS-202		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Understand different modalities and current techniques in image acquisition
- Describe how digital images are represented and stored efficiently depending on the desired quality, color depth, dynamics (time- varying data).
- Use the mathematical principles of digital image enhancement (contrast, gradients, noise).
- Analyze the constraints in image processing when dealing with larger data sets (efficient storage and compression schemes).
- Apply the knowledge primarily obtained by studying examples and cases in the field of biomedical imaging to other engineering disciplines.

Course Outline

- Data Sources and acquisition
- Characteristics of grey-level digital images
- Types of Image data Formats
- Pre-processing (Image stacking, Sub-setting & Geomatric and Atmospheric Corrections)
- Image transformation (Geometric and Affine)
- Batch Processing
- Image Mosaicking and Color Balancing
- Image Enhancement (Grey level transformations, Histogram equalization,)
- Image Filtering (Pan-sharpening, Fourier descriptors, Linear and non-linear filtering operations, Image and Separable convolutions, Sub-sampling and interpolation as convolution operations)
- Image Indices (NDVI, NDWI, NDSI, Leaf Area Index, etc)
- Image Classification (Types, Algorithms and Spatial modeler techniques)
- Signatures selection, feature space and evaluation
- Principal component analysis
- Morphological operations

- Accuracy Assessment and Field Verification

Practical:

- Intro to lab and software
- Hands on training on Spatial modeler in ERDAS Imagine
- Atmospheric correction of multi-spectral and hyper-spectral data sets
- Image Management (Import/Export & Display)
- Image Enhancement Techniques (Histogram equalization, filtering)
- Spectral and spatial digitizing
- Mosaicking and color balancing
- Rectification, Registration and Re-sampling
- Image processing techniques
- Signature selection
- Accuracy Assessment and Field Verification
- Individual/Group project with field work

Recommended Books

- Digital Image Processing by Rafael C. Gonzalez, Richard E. Woods, Publisher: Pearson, Edition: 4th Edition (2018), ISBN: 978-0133356724
- Remote Sensing and Image Interpretation by Thomas M. Lillesand, Ralph W. Kiefer, Jonathan Chipman, Publisher: Wiley, Edition: 8th Edition (2015), ISBN: 978-1118343242
- Introduction to Remote Sensing by James B. Campbell, Randolph H. Wynne, Publisher: Guilford Press, Edition: 5th Edition (2011), ISBN: 978-1609181754
- Digital Image Processing for Remote Sensing by K. S. Rajasekaran, K. S. Ganesh, Publisher: CRC Press, Edition: 1st Edition (2012), ISBN: 978-1439855293

Code	Global Navigation Satellite System	Credit Hours
RGS-203		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Identify various global satellite navigation systems and their operational principles.
- Understand the functioning and operational details of GNSS and similar systems.
- Analyze the shortcomings of such systems in real-life scenarios.
- Adapt to variations in various navigation systems-based devices and their operational mechanisms.

Course Outline

- Introduction to Navigation science,
- Available and Future Navigation Systems,
- Global satellite navigation systems
- Basic Mathematical Concept for Navigation Systems,
- Space Segment,
- Control Segment,
- User Segment,
- Point to point transmission,
- Point to area transmission,
- Differential GPS and Kinematics,
- Diffusion and interference,
- Application of Navigation system,
- GPS Error sources and Accuracy Assessment,
- Data transfer from and to a GPS receiver.

Practical

- GPS value reading,
- Easting Northing (latitude/ longitude) and elevation,
- Map Projections and Datum Settings,
- GPS based surveys,
- Tracking and data processing including GPS data display,
- Planimetric & vertical errors calculations,
- GPS Project

Recommended Books

- Van Sickle, J. (2008). *GPS for land surveyors*. CRC Press.
- Toth, P., & Vigo, D. (Eds.). (2014). *Vehicle routing: problems, methods, and applications* (Vol. 18). Siam.
- Bray, H. (2014). *You are here: From the Compass to GPS, the History and Future of how We Find Ourselves*. Basic Books.
- Denny, M. (2012). *The science of navigation: from dead reckoning to GPS*. JHU Press.

Code	Introduction to Earth Science	Credit Hours
IDS-201		3 (3-0)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Describe the structure of the Earth and solar system

- Discuss how the Earth's internal forces result in various surface features observed on a map or image
- Explain how the rock cycle results in the various types of rocks and minerals observed on the Earth
- Explain the composition of the atmosphere and human influences upon it
- Discuss how atmospheric circulation results in various climate patterns and weather phenomena
- Relate human actions to climate change
- Explain tides, currents, and circulation within the Earth's oceans

Course Outline

- Fundamentals of Earth science
  - The solar system: Size, The sun, Terrestrial planets, Jovian planets
  - Structure of the Earth: Core, Mantle, Crust
  - The scientific method as a framework to explore Earth science
- Earth's internal forces
  - Plate tectonics
  - Orogenesis
  - Volcanoes
  - Earthquakes
  - Folds and faults
- Earth materials
- Minerals: The rock cycle: Igneous, Sedimentary, Fossils and fossilization, Metamorphic
- Geologic time: Age of the Earth, Dating methods: Relative, Radiometric
- Surface processes: The water cycle, Water resources, Glacial weathering, Dry environments
- The atmosphere: Composition, Circulation in the atmosphere, Weather patterns, Climate patterns
- Extreme weather, Cyclones, Floods, Drought
- Climate change
- Oceans: Tides, Currents, Shorelines

Recommended Books

- Tarbuck, Edward J., Fredrick K. Lutgens, and Dennis G. Tasa. Earth Science. 2018.
- Fu, Y., Ma, Y., Zhong, L., Yang, Y., Guo, X., Wang, C., ... & Wang12, D. (2001). EARTH SCIENCES.
- Allaby, M. (Ed.). (2013). A dictionary of geology and earth sciences. Oxford University Press, USA.

SEMESTER IV				
Code	**S. No**	**COURSE**	**CREDIT HOURS**	**CATEGORY**
SSH-202	1	Civics and Community Engagement	2 (2-0)	General Education
SSH-203	2	Ideology and Constitution of Pakistan	2 (2-0)	General Education
MSC-201	3	Entrepreneurship	2 (2-0)	General Education
RGS-204	4	Active Remote Sensing	3 (2-1)	Major
RGS-205	5	Photogrammetry	3 (2-1)	Major
RGS-206	6	Digital Cartography	2 (1-1)	Major
RGS-207	7	Spatial Data Analysis	3 (2-1)	Major
ARAB-252		Translation of the Holy Quran IV		
	Total Credits (17)			

Code	**Civics and Community Engagement**	**Credit Hours**
SSH-202		**2 (2-0)**

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Demonstrate knowledge of civic rights, duties, and the role of citizens in a democratic society.
- Apply strategies to actively participate in and contribute to community development initiatives.
- Critically evaluate social, economic, and political issues affecting communities and propose solutions.
- Exhibit ethical leadership and teamwork skills to foster collaboration and positive change in communities.

Course Outline

Students may choose to engage in either (1) internship to gain on-the-job experience by attaching to different kinds of organizations such as business firms, startups, NGOs, government agencies, consulates, etc., or (2) research attachment to involve in research/development/community projects led by Faculty members; or (3) other forms of student attachment or internship vetted by the faculty. The internship/attachment is normally of at least 5 consecutive weeks full-time attachment during the summer or a minimum of 200 work hours during term time (or equivalent). Through first-hand practical experience and project-based learning, students are guided to look in the major social issues/problems

from their respective academic discipline as well as other relevant academic inputs from the instructor in the following areas:

- Environmental and Urban Systems
- Environmental Conservation and Sustainable Development
- Urban Renewal
- Populations and Well-being
- Public Health • Child & Youth Development
- Social Welfare • Education Needs
- Ageing
- Gender
- Ethnicity and Equal Opportunities
- Social Inequity • Human Rights
- Learning, Praxis and Governance
- Cultural Diversity
- Heritage and Community Collective Memory
- Political Governance
- Other emerging social issues endorsed by Department/Faculty.

Recommended Books

- Taking the Communications High Ground, PAS Memo, March/April 2012, American Planning Association (Rooney, Hart, and Johnson)
- Planning With Half a Mind: Why Planners Resist Emotion, Planning Theory and Practice 16(4):498-516 (Baum 2015)
- Planners and the Digital Commons: Perspectives, Techniques, and Engagement, PAS Memo January/February 2014, American Planning Association (Shuler)
- Using Online Tools for Public Engagement, PAS Quick notes No. 51, American Planning Association (Read 2014)

Code	Ideology and Constitution of Pakistan	Credit Hours
SSH-203		2 (2-0)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Have a better understanding of the rationale for the creation of Pakistan.
- Enable students to contribute in social, political and economic growth of Pakistan.
- Become a part of strong nation with a sense of ownership and responsibility towards Pakistan
- Play an active role toward sustainable development of Pakistan

Course Outline

- 1.Historical and Ideological Perspective
  a. Pakistan Movement
  • Aligarh Movement
  • Two Nations Theory
  b. Founders of Pakistan
  • Allama Muhammad Iqbal
  • Quaid-e-Azam Muhammad Ali Jinnah
  • Other Leaders (Women and other Pakistan Movement Leaders)
  c. Quaid's Vision for Pakistan
  d. Kashmir – An unfinished Agenda of Partition
- 2. Constitution of Pakistan
  a. An overview of constitutional development in Pakistan
  b. Salient features of the Constitution of 1973
  c. Constitutional Amendments
  d. Fundamental Rights and Responsibilities of Citizens
- 3. Contemporary Pakistan
  a. Pakistan's society, culture and demography – celebrating diversity
  b. Current Challenges: social, economic, environmental, political and external
  c. Nation's resilience in War on Terror
- 4. Economy of Pakistan
  a. An overview of Economy
  b. Services, Manufacturing and Agricultural Profile of Pakistan
  c. Regional Economic Cooperation
  d. One Belt One Road (OBOR) – CPEC
- 5. Land of Opportunities
  a. Physical features: diversity and beauty
  b. Natural resources – mineral, water, energy, agriculture & livestock, and marine resources
  c. Tourism and Culture
- 6. Pakistan's Foreign Policy
  a. Foreign Policy – Principles and Objectives
  b. Relations with Neighbors
  c. Major Economies
  d. Muslim World
  e. Geo-political and strategic significance of Pakistan in Regional and Global Politics
- 7. Pakistan in pursuit of Global Agenda
  a. SDGs-2030 – Pakistan Goals
  b. Commitments on Climate Change
  c. Peace and Security

Recommended Books

- Khalid B. Sayeed, Pakistan: The Formative Phase 1857 – 1948, Pakistan Publishing House, 1960
- Gulam Allana, Quaid-e-Azam: the story of Pakistan, Ferozsons, 1967.
- Shahid M. Amin, Pakistan's Foreign Policy: A Reappraisal, Oxford University Press, 2010.
- S. Akbar Zaidi, Issues in Pakistan's economy, Oxford University Press, 2003.
- Hamid Khan, Constitutional & political history of Pakistan, Oxford University Press, 2003
- Rafi Raza, *Pakistan in Perspective 1947-1997*, Oxford University Press, 2003
- Sharif-ul-Mujahid, *The Ideology of Pakistan* , Progressive Publishers, 1974.
- Ziring Lawrence, *Pakistan in the Twentieth Century,* Oxford University Press, 1997 –
- Burke S. M. & Ziring Lawrence, *Pakistan's Foreign Policy,* Oxford University Press, 1973. Mohammad Qadeer , Pakistan
- Climate Change Policies-Ministry of Climate Change, Islamabad- http://mocc.gov.pk/
- Sustainable Development Goals (SDGs)- www.pc.gov.web/sdg/sdgpak
- Economic Survey of Pakistan- http://finance.gov.pk/survey_1617.html
- Foreign Policies- Ministry of Foreign Affairs, Pakistan http://mofa.gov.pk/
- Population Census of Pakistan- Economic Survey of Pakistan http://finance.gov.pk/survey_1617.html
- Issues in Pakistan's Economy by S. Akbar Zaidi, ISBN: 0195790529.
- Pakistan's Foreign Policy: A Reappraisal by Shahid M. Amin. ISBN: 0195798015
- Newspapers editorial and selected journalistic writings on current affairs.
- Pakistan (Lands, Peoples, & Cultures) by Carolyn Black, Bobbie Kalman. ISBN:

Code	Entrepreneurship	Credit Hours
MSC-201		2 (2-0)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Develop a business plan with an appropriate business model
- Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial career
- Demonstrate the ability to find an attractive market that can be reached economically

Course Outline

- Introduction to Navigation science,
- Available and Future Navigation Systems,
- Global satellite navigation systems
- Basic Mathematical Concept for Navigation Systems,

- Space Segment,
- Control Segment,
- User Segment,
- Point to point transmission,
- Point to area transmission,
- Differential GPS and Kinematics,
- Diffusion and interference,
- Application of Navigation system,
- GPS Error sources and Accuracy Assessment,
- Data transfer from and to a GPS receiver.

Practical:

- Basic Concept-Entrepreneurship
- Innovation and Entrepreneurship
- Basic Plan Development Cycle
- Intellectual Rights
- Financial and Legal Modalities
- Marketing
- Industrial Competiveness
- Gap Analysis, Critical Thinking and Idea Generation
- Business Plan Development
- Successful Case Studies (local)

Recommended Books

- Michael J Etzel, Bruce J Walker, William J Stanton, Marketing, McGraw-Hill 2010
- William D. Bygrave and Andrew Zacharak, Entrepreneurship 2nd Edition, Wiley, 2012.
- Entrepreneurship by Hisrich, McGraw- Hill, 2009
- Principles of Marketing, Cotrell McGraw- Hill 2012
- Paul Burns and Jim Dew Hurst: Small Business and Entrepreneurship
- P.N. Singh: Entrepreneurship for Economic Growth
- Drucker, P., & Maciariello, J. (2014). Innovation and entrepreneurship. Routledge.
- Ionita, D. (2012). Entrepreneurial marketing: a new approach for challenging times. Management & Marketing, 7(1), 131.

Code	Active Remote Sensing	Credit Hours
RGS-204		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- understand the principles of active remote sensing systems
- have a basic understanding of polarimetry and interferometry
- process and handle radar data
- process and handle differnt forms of LiDAR data (waveform, discrete)
- interpret the information contained in radar and LIDAR data and use them in meaningful

Course Outline

- Introduction to Active Remote Sening, Properties of Microwaves vs Visible & Infrarad
- Radar and LIDAR Interactions with Manmade and Natural Objects
- The Radar/Lidar Equation
- Radar Polarimetry and Interferometry
- LIDAR systems
- Radar systems
- LIDAR data processing
- Radar data processing
- Application examples

Practical

- LiDAR and radar systems are used to create detailed maps of the Earth's surface, including elevation data, vegetation structure, and land cover.
- monitor natural disasters like floods, earthquakes, and landslides, providing real-time data for response and recovery efforts.
- deforestation, track ice sheet movement, and assess the impact of pollution on the environment.
- Agriculture and Forestry: monitor crop health, assess forest damage, and manage agricultural resources.
- map geological formations, identify subsurface features, and assess the risk of natural hazards.
- monitor urban expansion, assess infrastructure, and plan for future development.
- Radar and other active sensors are used for navigation, tracking objects, and monitoring traffic flow.

Recommended Books

- Principles and applications of imaging radar (Manual of remote sensing, Volume 2)
  LiDAR Remote Sensing and Applications

Code	Photogrammetry	Credit Hours
RGS-205		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Define and describe the terms photogrammetry and aerial photograph

- Understand the basic principles of photogrammetry
- Apply the knowledge to visually interpret the aerial photograph.
- Compare photogrammetry and remote Sensing.
- Evaluate the application of aerial photographs and its importance in natural Resource management

Course Outline

- Introduction: History, overview and importance of photogrammetry
- Analog, and digital photogrammetry
- Sensor, films and filters, data acquisition methods
- Types of aerial photographs: vertical, oblique, terrestrial, convergent and trimetrogon photographs
- Flight configuration of aerial photography: forward & side lap and forward gain
- Aerial photograph's marginal information
- Methods for calculation of scale and area: descriptive, graphical and representative friction method
- Interpretation of aerial photographs: shape, shadow, size, pattern, tone, texture and association
- Stereovision, Ray's Diagram, Porro-Koppe's principle, Stereoscopic analysis
- Introduction to Digital Photogrammetric Work Stations (DPWS)
- Concepts of UAVs, LIDAR and their applications
- DEM, DSM and DTM generation and their comparison,
- Ortho-photography/Ortho-image, applications: visual interpretation, identification and extraction of natural and man- made features, flood damage assessment and various types of mass-movement

Practical:

- Visual interpretation, Identification and Extraction of various land features
- DEM generation, Height measurement, scale & area calculations, and contouring by using Stereoscope and Photogrammetric Work Station

Recommended Books

- David, P. P., & James D. K. (2012). Aerial Photography and Image Interpretation 2nd Edition. John Wiley & Sons, Inc. New Jersey.ISBN-13: 978-0470879382
- Edward, M., Mikhail, J. S., Bethel, J., & Chris McGlone. (2001). Introduction to modern photogrammetry 1st Ed. Wiley, ISBN: 9780471309246
- Golwell, R.N. (1960). Manual of photographic Interpretation, New York.
- Judge, A.W. (1950). Streeoscopic photography: It application to science, industry and education. London.

- Karl, K. (2004). Photogrammetry – Geometry from Images and Laser Scans 2nd Ed. Walter de Gruyter, Berlin.ISBN: 9783110190076
- Paul, W., DeWitt,B., & Wikinson, B. (2014). Element of Photogrammetry with Application in GIS. McGraw Hill. ISBN- 13:978-0071761123
- Wilfried, L. (2009). Digital Photogrammetry – A Practical Course 3rd Ed. Springer. ISBN:9783540927259

Code	Digital Cartography	Credit Hours
RGS-206		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Providing basic knowledge of portraying spatial features from reality by using cartographic techniques.
- Providing training in coordinates and projection systems and map classification techniques.

Course Outline

- Introduction to Cartography and its history
- Nature of Cartography
- Map Types (Choropleth, Proportional Symbol
- Dot, Isarithmic
- Cartograms Flow, and Graduate Color Maps)
- Symbols, Lettering, Scale and direction
- Map Projections, Datum and Coordinate Systems, Generalization
- Land Use/Land Cover Schemas: standards for land cover/land use classification schemes Survey of Pakistan, Food and Agriculture Organization (FAO), United States Geological Survey (USGS), Coordination of Information on the Environment (CORINE).
- Thematic Maps, Descriptive Statistics, Class Intervals, Map Compilation, Map Design, Cartography and Ethics, Map Production, Project.

Practical:

- Map reading, Assignment on Types of Maps
- Understanding of Survey of Pakistan (SOP) symbology and Development of Symbol Charts
- Development of Graphical Map Projections
- Development of at least two map projections each from conical, cylindrical, and plane projection,
- Large to small scale map conversion
- Data classification and Thematic Mapping
- Map composite development
- Assignment on misleading cartography

Recommended Books

- Cromley, R. G. (1991) "Digital Cartography". Prentice Hall Inc.
- Jones, C. (1997), "Geographical Information Systems and Computer Cartography", 1st Edition, Prentice Hall. ISBN-10: 0582044391
- Kraak, M.J. and Ormeling, F.J. (1996), "Cartography- Visualization of Spatial Data", Longman Publishing Group. ISBN-10: 0582259533.
- Lliffe, J.C., and Lott, R. (2008), "Datum and Map Projections: For Remote Sensing, GIS and Surveying", 2nd Edition, Whittles Publishing, Scotland UK. ISBN: 142007041X
- Robinson, A.H., Morrison,J.L., Muehrcke, P. C., Kimerling, A.J., and Guptil,S.C. (1995), "Elements of Cartography", 6th edition, John Wiley & Sons, New York, ISBN-10: 0471555797
- Slocum, T. A.,, McMaster, R. B., Kessler, F. C. and Howard. H. H. (2009), "Thematic Cartography and Geographic Visualization", 3rd Edition, Upper Saddle River, NJ: Pearson Prentice Hall. ISBN:0-13- 229834-1

Code	Spatial Data Analysis	Credit Hours
RGS-207		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Identify the main functional components of GIS
- Understand the various types of Spatial analyses
- Implement standardized data input and management
- Simulate real world using various analytical techniques.

Course Outline

- Introduction to spatial data types
- Potentials of spatial data
- Modeling and storing field data
- Cluster analysis
- Boundary Analysis
- Spatial Analyses
- Point pattern analysis
- Spatial Autocorrelation
- Buffering, proximity and neighborhood functions
- Spatial interpolation, type, Methods / algorithms, measures on surfaces Derived

- Polylines and network Analyses
- Area objects and types of area objects
- Geometric properties of areas
- Map overlay
- Vector and raster overlay operations
- Ordinary Least Squares & Geographically Weighted Regression Techniques
- Problems in simple Boolean polygon overlay
- Multivariate data and multidimensional space
- New approaches to spatial analysis
- Surface modeling, DTM/DEM/DSM
- Multi-criteria and Multi-attribute Decision Making
- Uncertainties in spatial modeling.

Practical:

- Assignment on Spatial Analysis for various applications Geo-coding
- Point analysis exercise
- Interpolation of point data and surface modeling Network analysis exercise
- Arial analysis exercise Buffer analysis exercise Multivariate analysis
- Assignment on advanced spatial analysis Suitability analysis
- Risk Modeling, Assignment on uncertainties in spatial modeling

Recommended Books

- Albert, D. P., Gesler, W. M. and Levergood, B. (2000), "Spatial Analysis, GIS and Remote Sensing Application in Health Sciences" CRC Press.ISBN: 1575041014
- Atkinson, P. M., and Tate, N. (1999) "Advances in Remote Sensing and GIS Analysis", 1st Edition, John Wiley & Sons. UK. ISBN:0471985775
- Chang, K. T. (2010), "Introduction to Geographic Information Systems", McGraw Hill. ISBN: 007352283X
- Chrisman, N. (2001) "Exploring Geographic Information System", 2nd Edition, John Wiley & Sons, UK. ISBN: 0471314250
- Longely, P., Goodchild, M., Maquire, D., and Rhind, D. W. (2005), "Geographic Information Systems: Principles, Techniques, Management and Applications", 2nd Edition, John Wiley & Sons. ISBN: 0471735450
- Stillwell, J. and Clarke, G. (2004), "Applied GIS and Spatial Analysis", John Wiley & Sons, UK.
- Sullivan, D. and Unwin, D. (2010), "Geographic Information Analysis", John Wiley &SonsInc. ISBN: ISBN10: 0470288574

- Verbyla, D. (2007), “Practical GIS Analysis”, 1st Edition, Taylor & Francis. ISBN: 0415286093

SEMESTER V				
Code	**S. No**	**COURSE**	**CREDIT HOURS**	**CATEGORY**
IDS-301	1	Introduction to City and Regional Planning (IDS-III)	3 (2-1)	Interdisciplinary
IDS-302	2	Precision Agriculture (IDS-IV)	3 (3-0)	Interdisciplinary
RGS-301	3	Spatial Data Infrastructure and Standardization	3 (3-0)	Major
RGS-302	4	Mobile Data Acquisition and Mapping	3 (2-1)	Major
RGS-303	5	GIS Programming and Customization	3 (2-1)	Major
	Total Credits (15)			

Code	**Introduction to City and Regional Planning**	**Credit Hours**
IDS-301		**3 (2-1)**

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Define and describe the terms of Planning, City, Regional and administrative units ranging from District, Town, Union Council in context of geographical and demographical parameters.
- Understand the Planning Process, basic principles, elements and types of planning.
- Understand the planning systems being practiced in Pakistan at Federal, Provincial and Local level.
- Compare the advantages and disadvantages of planned and unplanned human settlements

Course Outline

- Introduction to City and Regional Planning, Definitions and Terms.
- Justification and Aims of Planning.
- Planning Principles and Elements of Planning.
- Scope, Nature and Purpose of Physical Planning.
- Levels of Planning.
- Types of Plans and Planning.
- Planning and its Relationship with other Professions.
- Emerging Trends in Planning.

- The Planning Process.
- Overview of Old and New Towns Designed in the Developed and Developing Countries.
- Historical and Modern Cities of Pakistan.
- Characteristics of Planned and Unplanned Human Settlements.
- Introduction to Planning System in Pakistan.
- Functions of Professional Planners in Development Authorities, Towns and Districts.

Practical:

- Field visits to study the characteristics of planned and unplanned areas.
- Visit to local planning institutions / organizations to understand the systems and scope of the planning profession.

Recommended Books

- Wade Graham (2017), Dream Cities: Seven Urban Ideas That Shape the World Paperback – January 24, 2017, Amazon.
- Geddes, P. (2016), Cities in Evolution: An introduction to the town planning movement and to the study of civics, Amazon.
- Le Gates, R.T., and Stout, F. (eds.) (2011), The City Reader, Routledge.
- Hall, P., and Tewdwr-Jones, M. (2011), Urban and Regional Planning, Routledge.
- Gosh, R., and Gupta, K.R. (2008), Development Studies.
- Hall, P. (2002) Cities of Tomorrow: An Intellectual History of Urban Planning and Design in the Twentieth Century, Blackwell Publishing.
- Greed, Clara (2000), Introducing planning, The Athlone press, London.
- Allmendinger, Philip (2000), Introduction to Planning Practice, Wiley, New York.
- Blowers, A., and Evans B. (eds.) (1997), Town Planning into the 21st Century, Routledge.
- Government of Pakistan (1986) National Reference Manual on Planning and Infrastructure Standards, E&UA Div. Ministry of Housing and Works, Islamabad.

Code	Precision Agriculture	Credit Hours
IDS-302		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Use data analytics and sensor technologies to optimize crop production, reduce waste, and improve decision-making.

- Design and implement precision farming techniques, such as variable rate application (VRA) and automated machinery, for sustainable agriculture.
- Assess the environmental benefits and economic viability of precision agriculture technologies in farming systems.

Course Outline

- Explain precision agriculture
- Explain global positioning system
- Explain geographical information system
- Discuss soil fertility sensors
- Discuss yield monitors
- Explain Variable Rate Technology (VRT)
- VRT fertilizer applicators, plant protection VRT applicators
- Describe remote sensing
- Discuss application of remote sensing in precision agriculture
- Generate crop management zones and soil maps
- Discuss monitoring of crop health
- Discuss management decision support systems
- Discuss future prospects and developments

Practical:

- ArcGIS 10.4, ERDAS IMAGINE, DSSAT 4.6, GS+
  Practical, trainings and field work include:
- Use of GPS Receiver, Differential Global Positioning System (DGPS), Process of Spatial Variability Analysis, Crop monitoring by UAV, Application of Variable Rate Technology

Recommended Books

- Pedersen, S. M., & Lind, K. M. (Eds.). (2017). Precision agriculture: Technology and economic perspectives (pp. 52-53). Cham, Switzerland: Springer International Publishing.
- Bechar, A. (2021). Innovation in Agricultural Robotics for Precision Agriculture. Cham, Switzerland: Springer International Publishing.
- Zhang, Q. (2016). Precision agriculture technology for crop farming (p. 374). Taylor & Francis.

Code	Spatial data infrastructure	Credit Hours
RGS-301		3 (3-0)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Understand the basic working principles of SDI
- Create and deploy working prototypes of SDI
- Describe the working principles of an SDI and its component elements

Course Outline

- Need and main components of SDI
- Clearing house architecture
- National Geospatial Clearinghouse,
- Metadata concepts, its structures and functionality,
- System Architecture for SDI Interoperability,
- Client Server Architecture
- Data Quality Information (DQI) Accuracy,
- Precision,
- Bias Error Modelling,
- Data Modelling. Abstraction of real world,
- Types of abstraction
- Problems of information sharing (Heterogeneities),
- Distributed database concept,
- GIS Internet Services and SDI Technologies
- Available Services technologies that support internet GIS services
- Commercial tools for Internet GIS
- Legal aspects of SDI
- Comparison of working SDI's,
- Development of Metadata according to Standards
- Development of Architecture of SDI
- Data Standardization
- Data transformations and translations
- Web Publishing & development

Recommended Books

- P. Williamson, Abbas Rajabifard, Developing Spatial Data Infrastructures: From Concept to Reality, Taylor & Francis, 2003
- Yukio Sadahiro, Spatial Data Infrastructure for Urban Regeneration, Springer, 2008

- Harlan Joseph Onsrud, Research and Theory in Advancing Spatial Data Infrastructure Concepts, ESRI, 2007
- Javier Nogueras-Iso, F. Javier Zarazaga-Soria, Pedro R. Muro- Medrano, Geographic Information Metadata for Spatial Data Infrastructures: Resources, Interoperability and Information Retrieval, Springer, 2005

Code	Mobile Data Acquisition and Mapping	Credit Hours
RGS-207		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Understand the principles and technologies of mobile data acquisition and mapping.
- Use mobile devices and applications for field data collection and mapping.
- Integrate mobile-collected data with GIS and remote sensing platforms.
- Analyze and visualize mobile-acquired geospatial data.
- Develop practical skills in using mobile GIS tools for real-world applications.

Course Outline

- Introduction to Mobile Data Acquisition and Mapping
- Overview of mobile GIS and its applications
- Advantages and limitations of mobile data acquisition
- Comparison with traditional data collection methods
- Mobile Devices and Sensors
- Types of mobile devices (smartphones, tablets, GPS devices)
- Built-in sensors (GPS, accelerometer, camera, etc.)
- External sensors and accessories for enhanced data collection
- Mobile GIS Applications
- Overview of popular mobile GIS apps (e.g., ArcGIS Field Maps, QField, Survey123)
- Data collection workflows using mobile GIS apps
- Offline data collection and synchronization
- Field Data Collection Techniques
- Designing field surveys and data collection forms
- Best practices for accurate and efficient data collection
- Handling challenges in field environments (e.g., connectivity, battery life)
- Integration with GIS and Remote Sensing
- Importing and processing mobile-collected data in GIS software
- Combining mobile data with remote sensing imagery
- Data validation and quality control

- Visualization and Analysis of Mobile Data
- Creating maps and visualizations from mobile-collected data
- Spatial analysis techniques for mobile data
- Case studies: Urban planning, environmental monitoring, disaster management

Practical:

- Introduction to mobile GIS apps (e.g., ArcGIS Field Maps, QField)
- Setting up mobile devices for field data collection
- Designing and testing field survey forms
- Conducting field data collection using mobile devices
- Importing and processing mobile-collected data in GIS software (e.g., QGIS, ArcGIS)
- Visualizing and analyzing mobile-collected data
- Mini-project: Field data collection and mapping for a real-world application

Recommended Books

- Kennedy, M. (2018). Mobile GIS: Mapping the world with your smartphone. CRC Press.
- Zhu, X. (2016). GIS for environmental applications: A practical approach. Routledge.
- Graser, A. (2020). QGIS for field data collection. Locate Press.
- Smith, D. (2019). ArcGIS for mobile data collection. Esri Press.
- Schaeffer, J. (2017). Field data collection with mobile GIS: Techniques and applications. Wiley.
- de Smith, M. J., Goodchild, M. F., & Longley, P. A. (2018). Geospatial analysis: A comprehensive guide to principles, techniques, and software tools (6th ed.). The Winchelsea Press.
- Wilmott, C. (2020). Mobile mapping: Space, cartography, and digital. Routledge.

Code	GIS Programming and Customization	Credit Hours
RGS-207		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Understand the basic working environments of Python
- Apply geoprocessing techniques using Arcpy code.
- Implement automated tasks using Arcpy code.
- Understand and implement the use of cursors.
- Create usable ArcObjects code for typical GIS programming tasks in .NET.

Course Outline

- Fundamentals of geo-processing
- Fundamentals of Python
- Usage of variables and special data types
- Naming conventions and reserved words
- testing and printing variable values
- Looping and control structures
- Debugging
- optional and required parameters
- Objects, properties and methods
- the OO paradigm
- Object Model Diagrams
- The geo-processor object introduction
- Functions and parameters, passing and returning values
- Multiple inputs and complex parameter passing
- Selections and sets
- SQL basics
- Writing results to disk, various formats and switches
- Advanced topics and further directions
- Num.py for numerical modeling
- Architecture of ArcObjects
- Main Arc Objects classes, classes and interfaces (IFeatureLayer, IFeatureClass, IFeature, IFeatureCursor, etc.) other useful modules

Practical:

- Introduction to Lab
- Looping statements
- Getting and setting object parameters
- Creating features and feature classes
- Editing layer's display properties
- Changing/editing and summarizing attribute data
- Exploring the geo-processor object,
- Projects

Recommended Books

- Eric Pimpler (2013), "Programming ArcGIS 10.1 with Python Cookbook".
- Bugg, K.E. (2003), "GIS Programming: Prepare for the Gathering Storm", GEO World.

- Kropla, B. (2005), “Beginning Map Server: Open Source GIS Development”, 1st Edition, Apress, Co. ISBN: 1590594908
- Ralston, B. A. (2001), “Developing GIS Solutions with Map Objects and Visual Basic”, Onward Press, New York. ISBN: 0766854388
- Rigaux, P., Scholl, M. and Voisard, A. (2001), “Spatial Databases: With Application to GIS” 1st Edition, Morgan Kaufmann. ISBN: 1558605886.

SEMESTER VI				
Code	**S. No**	**COURSE**	**CREDIT HOURS**	**CATEGORY**
RGS-304	1	Research Methodology	3 (3-0)	Major
RGS-305	2	Spatial Decision Support Systems	3 (3-0)	Major
RGS-306	3	Spatial Databases	3 (2-1)	Major
RGS-307	4	Hyperspectral Remote Sensing	3 (2-1)	Major
	5	Elective-I	3 (3-0)	Major
	6	Elective-II	3 (3-0)	Major
	Total Credits (18)			

Code	**Research Methodology**	**Credit Hours**
RGS-304		**3 (3-0)**

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Understand the fundamental principles of research and its significance in scientific studies.
- Differentiate between various research methodologies and their applications.
- Develop a research design, including problem formulation, hypothesis development, and data collection strategies.
- Apply qualitative and quantitative research techniques for data analysis.
- Write scientific reports, research papers, and proposals effectively.

Course Outline

- Introduction to Research (Definition, Importance, and Characteristics)
- Scientific Method and Research Process
- Types of Research (Basic vs. Applied, Qualitative vs. Quantitative, Experimental vs. Observational)
- Formulating a Research Problem and Developing a Hypothesis
- Research Design and Methodologies (Qualitative, Quantitative, and Mixed Methods)
- Sampling Techniques and Data Collection Methods (Surveys, Interviews, Experiments)
- Data Analysis Techniques (Descriptive and Inferential Statistics)
- Literature Review and Citation Management (EndNote, Mendeley, Zotero)
- Writing Research Proposals, Reports, and Scientific Papers

- Ethical Considerations in Research (Plagiarism, Bias, and Academic Integrity)
- Statistical Tools for Research (Overview of SPSS, R, and Python)
- Presentation and Communication of Research Findings
- Future Trends in Research Methodology and Scientific Innovation

Recommended Books

- Kothari, C. R. (2004). Research Methodology: Methods and Techniques. New Age International.
- Creswell, J. W. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. SAGE Publications.
- Kumar, R. (2019). Research Methodology: A Step-by-Step Guide for Beginners. SAGE Publications.
- Walliman, N. (2017). Research Methods: The Basics. Routledge.
- Yin, R. K. (2017). Case Study Research and Applications: Design and Methods. SAGE Publications

Code	Spatial Decision Support Systems	Credit Hours
RGS-305		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Define and differentiate conventional and spatial decision support systems.
- Understand the components of SDSS.
- Compare various technologies that are important in developing new SDSS, including programming languages, development environments, and spatial libraries.
- Apply the methods for tailoring SDSS into work environment.

Course Outline

- Introduction to Spatial Decision Making (Need, Process, Evolution and Trends)
- Components of Traditional DSS
- Components of SDSS
- Methods and Techniques to Support Spatial Decisions
- Modeling Techniques (Generic Models and Application-Specific Models)
- GIS Software Used in SDSS
- SDSS Software Components
- Design and Development of SDSS from Scratch

- Enabling Technologies for the Development of Desktop
- Web-Based SDSS Development and Architecture
- SDSS Application Domains
- SDSS Challenges (Technical, Technological, Social, Policy, and Organizational and Educational)
- Future Trends and Directions

Practical:

- Collaborative Decision -Making Software Packages, INDEX®
- Populating a data warehouse using different loading facilities
- Running different queries for extraction of results
- ArcGIS Server-based SDSS and Map Server-based SDSS
- Heuristic modeling using Marxan
- Populating and using an OLAP tool

Recommended Books

- De Montis, A. (2010). Spatial Decision Support for Urban and Environmental Planning. A collection of case studies, D. Geneletti,
- Abdullah (Eds.). ArahPendidikan Publishers (2009).
- E. Turban, J. Aronson and T. Liang (2004); Decision Support Systems and Intelligent Systems, 7th Edition, Prentice Hall. ISBN: 0130461067
- Jankowski, P., &Nyerges, T. (2001). GIS for group decision making. CRC Press.
- Power, D. J., Sharda, R., & Burstein, F. (2015). Decision support systems. John Wiley & Sons, Ltd.
- S. Ramanathan and DeGroote, John (2011); Spatial Decision Support Systems; CRC Press, 487 pages

Code	Spatial Databases	Credit Hours
RGS-207		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- reasons for using spatial databases and the principles behind their design, including spatial data types, indexing, and storage methods.
- Understand the various types of Spatial analyses

- design and execute spatial queries using SQL and other relevant tools to retrieve and analyze spatial data
- differentiate between different types of spatial data, such as points, lines, polygons, and raster data,

Course Outline

- Introduction to Spatial Database
- Basic Open GIS Standards for Spatial Database
- Relational Database in Spatial domain, Object Relational Database
- Spatial Query and Spatial Operators
- Basics of Geodatabase
- Basic spatial and geometry tests
- Table operations
- Topology in Spatial Database
- Spatial Indexing
- Introduction to lab and software
- Linking with GIS software
- Development of geo-databases and spatial databases, Topological testing
- Spatial Queries and Spatial Operators
- Assignments on application of spatial queries

Practical:

- Assignment on Spatial Analysis for various applications Geo-coding
- Point analysis exercise
- Interpolation of point data and surface modeling Network analysis exercise
- Arial analysis exercise Buffer analysis exercise Multivariate analysis
- Assignment on advanced spatial analysis Suitability analysis
- Risk Modeling, Assignment on uncertainties in spatial modeling

Recommended Books

- . Elmasri, R. and Navathe, S.B. (2004) "Fundamentals of Database Systems" Addison-Wesley Pub. Co ISBN – 0-201760355
- 2. Konstantin Krivoruchko (2011), "Spatial Statistical Data Analysis for GIS Users" ISBN: 1589481615
- 3. Manfred M. F. and Jinfeng, W. (2011), "Spatial Data Analysis: Models, Methods and Techniques". 1stEdition, ISBN-10: 3642217192
- 4. Oracle press release 2010, Oracle Spatial 11g user guide and reference
- 5. OGC release 2011, Open GIS Implementation Specification for Geographic information – Simple feature access Part 2: SQL option

- 6. Rigaux, P. Scholl, M. and Voisard, A.(2001) “Spatial Databases: With Application to GIS” Morgan Kaufmann; 2nd Edition

Code	Hyperspectral Remote Sensing	Credit Hours
RGS-307		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Explain the fundamental concepts of hyperspectral remote sensing and its advantages over multispectral imaging.
- Understand the working principles of hyperspectral sensors and platforms.
- Analyze spectral signatures for various natural and artificial materials.
- Apply hyperspectral image processing techniques, including classification and spectral unmixing.
- Utilize hyperspectral data for real-world applications in agriculture, geology, environmental monitoring, and urban studies.

Course Outline

- Introduction to Hyperspectral Remote Sensing (Concepts, History, and Evolution)
- Comparison of Multispectral and Hyperspectral Imaging
- Hyperspectral Sensor Systems (Spaceborne, Airborne, UAV-based)
- Spectral Resolution and Spectral Signatures of Materials
- Preprocessing of Hyperspectral Data (Radiometric and Geometric Corrections)
- Dimensionality Reduction Techniques (PCA, MNF, ICA)
- Spectral Unmixing and Endmember Extraction
- Hyperspectral Image Classification Techniques (Spectral Angle Mapper, SVM, Neural Networks)
- Hyperspectral Data Fusion and Integration with GIS
- Applications of Hyperspectral Remote Sensing (Agriculture, Geology, Environmental Monitoring, Disaster Management, Urban Planning)
- Challenges in Hyperspectral Data Processing and Analysis
- Future Trends in Hyperspectral Remote Sensing

Practical:

- Introduction to Hyperspectral Data Visualization and Interpretation
- Downloading and Preprocessing Hyperspectral Datasets
- Spectral Signature Analysis using Hyperspectral Software
- Atmospheric and Radiometric Corrections
- Spectral Unmixing and Feature Extraction

- Hyperspectral Image Classification using Machine Learning Techniques
- Case Study: Application of Hyperspectral Remote Sensing in a Selected Domain

Recommended Books

- Chang, C.-I. (2013). Hyperspectral Data Processing: Algorithm Design and Analysis. Wiley.
- Schott, J. R. (2007). Remote Sensing: The Image Chain Approach. Oxford University Press.
- Thenkabail, P. S., Lyon, J. G., & Huete, A. (2018). Hyperspectral Remote Sensing of Vegetation. CRC Press.
- Plaza, A., & Chang, C.-I. (2016). High-Performance Computing in Remote Sensing. CRC Press.
- Landgrebe, D. (2003). Signal Theory Methods in Multispectral Remote Sensing. Wiley-Interscience.

SEMESTER VII				
Code	**S. No**	**COURSE**	**CREDIT HOURS**	**CATEGORY**
RGS-401	1	Web GIS	3 (2-1)	Major
RGS-402	2	Artificial Intelligence in RS and GIS	3 (2-1)	Major
RGS-403	3	Spatial Data Modelling	3 (2-1)	Major
	4	Elective-III	3 (3-0)	Major
	5	Elective-IV	3 (3-0)	Major
	Total Credits (15)			

Code	**Web GIS**	**Credit Hours**
RGS-401		**3 (2-1)**

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Acquire skills how to make different types of Web Maps.
- Integrate Spatial Databases with Web Applications
- Publish maps online using Open Source Software (Carto DB, fusion Tables, Geoserver, etc).
- Read data from various data sources
- Process Spatial data with FOSS (Free and Open Source Software)
- Draw and query maps on the server using Web Map Service
- Put layers together with a web mapping API
- Learn how to Explore open data, VGI, and crowd sourcing

Course Outline

- Components of Web GIS
- GIS Server, Web Server and Database Server
- GIS / Web Server Architecture
- Cloud Computing process in relation to Web GIS
- Databases and SQL
- Web GIS Servers
- Web Editors used by Industry professionals for Webpage design
- HTML, PHP, CSS and JavaScript code
- HTML with GUI
- CSS and JavaScript into web pages for GIS
- Templates as an alternative solution to creating a foundation for web-based GIS maps
- APIs for web mapping

- Map servers and their applications
- Analytics on web maps

Practical:

- Introduction to key concepts in Web mapping
- System architecture for web mapping
- Understanding Free and Open Source Software and its use in web mapping
- WMS Services
- System architecture for web mapping
- Elements of a web map
- Collaborative web maps
- Spatial data processing with FOSS libraries
- Drawing and querying maps on the server using Web Map Service
- Map APIs
- Web based data editing
- Drawing vector layers on the client side
- Working with vector KML
- Working with GeoJSON
- Symbolizing vector layers in OpenLayers
- Adding interactive GeoJSON layers in OpenLayers
- GIS analysis on the web

Recommended Books

- Fu, P., & Sun, J. (2010). Web GIS: principles and applications. Esri Press.
- Sui, D., Elwood, S., & Goodchild, M. (Eds.). (2012). Crowdsourcing geographic knowledge: volunteered geographic information (VGI) in theory and practice. Springer Science & Business Media.
- Longley, P., & Batty, M. (2003). Advanced spatial analysis: the CASA book of GIS. ESRI
- Petroutsos, E. (2014). Google Maps: Power Tools for Maximizing the API. McGraw Hill Professional.

Code	Artificial Intelligence in Remote Sensing and GIS	Credit Hours
RGS-402		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Understand the fundamentals of Artificial Intelligence (AI) and its role in Remote Sensing (RS) and Geographic Information Systems (GIS).
- Differentiate between Machine Learning (ML), Deep Learning (DL), and traditional geospatial analysis methods.

- Apply AI-based techniques for image classification, object detection, and predictive modeling in RS and GIS.
- Utilize AI tools and libraries for geospatial data processing and analysis.
- Evaluate real-world AI applications in environmental monitoring, urban planning, disaster management, and land-use analysis.

Course Outline

- Introduction to Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL)
- AI in Remote Sensing and GIS: An Overview
- Supervised, Unsupervised, and Reinforcement Learning in Geospatial Analysis
- AI-based Image Classification Techniques (Random Forest, SVM, CNN, RNN)
- Object Detection and Feature Extraction using AI in Remote Sensing
- Deep Learning Architectures for Hyperspectral and Multispectral Image Processing
- AI in Change Detection and Land Cover Classification
- Big Data Analytics and AI in Geospatial Sciences
- Integration of AI with GIS for Spatial Decision Support Systems (SDSS)
- AI Applications in Disaster Management, Environmental Monitoring, and Precision Agriculture
- Challenges and Ethical Considerations in AI for RS and GIS
- Future Trends and Emerging Technologies in AI for Geospatial Applications

Practical:

- Introduction to AI and ML Libraries (TensorFlow, PyTorch, Scikit-Learn)
- Hands-on with Google Earth Engine (GEE) and AI for RS Applications
- Implementing Supervised and Unsupervised Classification on RS Data
- Deep Learning-based Image Classification using Convolutional Neural Networks (CNN)
- Object Detection and Feature Extraction in Satellite Imagery
- AI-driven Change Detection using RS Datasets
- AI-based Spatial Analysis and Predictive Modeling in GIS
- Case Study: AI Applications in a Selected Geospatial Field

Recommended Books

- Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. MIT Press.
- Lary, D. J. (2018). Artificial Intelligence and Deep Learning for Earth Sciences. Springer.
- Li, X., & Zhu, X. (2020). Remote Sensing Image Classification Using Deep Learning. Springer.
- Janowicz, K., Gao, S., McKenzie, G., & Hu, Y. (2021). AI and Machine Learning in GIS. CRC Press.
- Ma, L., Liu, Y., Zhang, X., Ye, Y., Yin, G., & Johnson, B. A. (2019). Deep Learning in Remote Sensing Applications: A Review. ISPRS Journal of Photogrammetry and Remote Sensing.

Code	Spatial Data Modelling	Credit Hours
RGS-403		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Understand the fundamental concepts of spatial data modeling and its role in GIS.
- Differentiate between vector and raster data models and their applications.
- Develop and implement spatial models for geospatial analysis.
- Apply geostatistical techniques for spatial data interpolation and prediction.
- Utilize spatial databases and programming tools for advanced spatial modeling.

Course Outline

- Introduction to Spatial Data Modeling (Concepts, Evolution, and Importance)
- Types of Spatial Data Models (Vector, Raster, TIN, and Hybrid Models)
- Spatial Data Structures and Storage Formats
- Spatial Relationships and Topology in GIS
- Conceptual, Logical, and Physical Models for Spatial Data
- Geostatistical Modelling (Kriging, IDW, Regression Models)
- Spatial Interpolation and Prediction Techniques
- Network and Surface Modeling in GIS
- Spatial Decision Support Systems (SDSS) and Multi-Criteria Decision Analysis (MCDA)
- Integration of Spatial Data Models with Machine Learning and AI
- Database Management for Spatial Modeling (PostGIS, Spatial SQL)
- Future Trends in Spatial Data Modeling and Big Data Analytics

Practical:

- Introduction to Spatial Data Modeling Tools (ArcGIS, QGIS, PostGIS)
- Vector and Raster Data Processing Techniques
- Implementing Spatial Interpolation Methods (Kriging, IDW)
- Network Analysis and Surface Modelling in GIS
- Developing Spatial Models Using Python and R
- Geostatistical Analysis using GIS Software
- Building and Querying Spatial Databases
- Case Study: Application of Spatial Modeling in Urban Planning or Environmental Analysis

Recommended Books

- Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2015). Geographic Information Systems and Science. Wiley.
- Burrough, P. A., & McDonnell, R. A. (2015). Principles of Geographical Information Systems. Oxford University Press.

- O'Sullivan, D., & Unwin, D. J. (2010). Geographic Information Analysis. Wiley.
- Fotheringham, A. S., Brunsdon, C., & Charlton, M. (2002). Geographically Weighted Regression: The Analysis of Spatially Varying Relationships. Wiley.
- De Smith, M. J., Goodchild, M. F., & Longley, P. (2018). Geospatial Analysis: A Comprehensive Guide. Winchelsea Press.

SEMESTER VIII				
Code	**S. No**	**COURSE**	**CREDIT HOURS**	**CATEGORY**
RGS-404	1	Unmanned Aerial Vehicle and Data Processing	3 (2-1)	Major
RGS-405	2	Machine Learning in Spatial Data	3 (2-1)	Major
	3	Elective-V	3 (3-0)	Major
	4	Elective-VI	3 (3-0)	Major
CAP-401	5	Capstone Project	3 (3-0)	Capstone Project
	Total Credits (15)			

Code	**Unmanned Aerial Vehicle and Data Processing**	**Credit Hours**
RGS-404		**3 (2-1)**

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Understand the design, development, and operational principles of UAVs.
- Explore autonomous systems and their applications in aerospace.

Course Outline

- Overview of UAV Types and Classifications.
- UAV Aerodynamic Principles and Flight Dynamics.
- Propulsion Systems for UAVs: Electric, Internal Combustion, and Hybrid.
- Flight Control Systems: PID Controllers, Autopilots, and Stability Augmentation.
- Sensors and Actuators Used in UAVs.
- UAVs Materials and Manufacturing Techniques
- UAV Navigation and GPS/INS Integration.
- Communication Systems and Data Links for UAVs.
- Data Acquisitioning and Data Visualization Techniques

- Ground Control Stations and UAV Operation.
- Autonomous Flight and AI-Driven Decision-Making.
- Obstacle Avoidance and Path Planning Algorithms.
- Regulatory Frameworks and Airspace Management for UAVs.
- UAV Payload Integration: Cameras, Sensors, and Delivery Systems.
- Ethical Considerations and Privacy Concerns in UAV Use.
- Case Studies: UAV Applications in Military, Agriculture, and Disaster Management.
- Future Trends and Innovations in UAV Technology.

Practical:

- Hands-on practice operating a UAV system a. Piloting around obstacles b. Understanding orientation c. Interfacing with sensors and pilot software d. troubleshooting
- Data collection and processing with on-board UAV sensors a. Magnetometers b. Accelerometers c. Global Positioning Systems (GPS) d. Imaging, temperature, humidity sensors e. troubleshooting
- Basic concepts of video capture and data transfer

Recommended Books

- Kimon P. Valavanis, George J. Vachtsevanos (Editors), "Handbook of Unmanned Aerial Vehicles", Springer
- Reg Austin, "Unmanned Aircraft Systems: UAVs Design, Development and Deployment", Wiley
- Randy Beard, and Tim McLain, "Small Unmanned Aircraft: Theory and Practice", Princeton University Press
- Ahmad Taher Azar and Anis Koubaa, "Deep Learning for Unmanned Systems", Springer International Publishing
- Yasmina Bestaoui Sebbane, "Intelligent Autonomy of UAVs: Advanced Missions and Future Use", CRC Press

Code	Machine Learning in Spatial Data	Credit Hours
RGS-405		3 (2-1)

Learning Outcomes

Upon successful completion of the course, the student will be able to:

- Understand the principles of machine learning and its applications in spatial data analysis.
- Preprocess and prepare spatial datasets for machine learning tasks.
- Apply supervised and unsupervised machine learning algorithms to solve geospatial problems.
- Evaluate and interpret the performance of machine learning models in the context of spatial data.
- Develop practical skills in using Python/R and GIS software for machine learning in spatial data analysis.

Course Outline

- Introduction to Machine Learning and Spatial Data
  Overview of machine learning (ML)
  Types of ML: Supervised, Unsupervised, and Reinforcement Learning
  Spatial data characteristics and challenges
  Applications of ML in RS and GIS

- Spatial Data Preprocessing
  Data collection and cleaning
  Feature engineering for spatial data
  Normalization and transformation of spatial datasets
  Handling missing data and outliers

- Supervised Learning for Spatial Data
  Regression models: Linear Regression, Decision Trees, Random Forests
  Classification models: Support Vector Machines (SVM), k-Nearest Neighbors (k-NN)
  Model evaluation: Accuracy, Precision, Recall, F1-Score, ROC-AUC

- Unsupervised Learning for Spatial Data
  Clustering techniques: k-Means, DBSCAN, Hierarchical Clustering
  Dimensionality reduction: Principal Component Analysis (PCA), t-SNE
  Applications in land cover classification and spatial pattern detection

- Deep Learning for Spatial Data
  Introduction to neural networks
  Convolutional Neural Networks (CNNs) for image-based spatial data
  Applications in satellite imagery analysis

- Spatial Data Visualization and Interpretation
  Visualizing ML results in GIS software
  Interpreting model outputs for decision-making
  Case studies: Urban planning, environmental monitoring, disaster management

Practical:

- Introduction to Python/R for spatial data analysis (Libraries: NumPy, Pandas, GeoPandas, Scikit-learn)
- Preprocessing spatial data: Cleaning, normalization, and feature extraction
- Implementing supervised learning algorithms (e.g., Random Forest for land use classification)
- Applying unsupervised learning techniques (e.g., k-Means for clustering urban areas)
- Visualizing machine learning results using GIS software (e.g., QGIS, ArcGIS)
- Case study: Predicting deforestation using satellite imagery and ML models

- Mini-project: Developing a machine learning pipeline for a real-world spatial problem

Recommended Books

- Müller, A. (2022). Machine learning and GIS: A comprehensive guide to geospatial data analysis. Springer.
- de Smith, M. J., Goodchild, M. F., & Longley, P. A. (2018). Geospatial analysis: A comprehensive guide to principles, techniques, and software tools (6th ed.). The Winchelsea Press.
- Raschka, S., & Mirjalili, V. (2019). Python machine learning (3rd ed.). Packt Publishing.
- Wegmann, M., Leutner, B., & Dech, S. (2016). Remote sensing and GIS for ecologists: Using open source software. Pelagic Publishing.
- Camps-Valls, G., Tuia, D., Zhu, X. X., & Reichstein, M. (2021). Deep learning for the earth sciences: A comprehensive approach to remote sensing, climate science, and geosciences. Wiley.
- Géron, A. (2022). Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow (3rd ed.). O'Reilly Media.

Code	Capstone Project	Credit Hours
CAP-401		3 (3-0)

It is a mandatory degree award requirement of three (03) credit hours for BS in Remote Sensing and GIS. A capstone project is multifaceted body of work that serves as a culminating academic and intellectual experience for students. The capstone project must be supervised and graded by a faculty member as per the protocols prescribed by the concerned department. This requirement cannot be substituted with additional course work or internship.