Syllabus

MS Geomatics (GIS/RS) Program

2022 ONWARDS

DEPARTMENT OF GEOGRAPHY & GEOMATICS
UNIVERSITY OF PESHAWAR, PAKISTAN

Scheme of studies for
MS Geomatics (GIS/ Remote Sensing)

Course Code	*Course title*	*Credit hours*
List of Minor courses		
GM 701	Research Methods	3
GM 702	Geo-Statistics	3
List of Major Courses		
GM 703	Geographic Information System: Concepts and Principles	3
GM 704	Remote Sensing	3
GM 705	Fundamentals of Geography	3
GM 706	Mapping and Surveying	3
GM 707	Spatial data Modelling	3
GM 708	Geodatabase and Programming	3
GM 709	Digital Cartography	3
GM 710	Digital Image Processing	3
GM 711	Spatial Decision Support System	3
GM 712	Integrated Land and Water information system	3
GM 713	Modeling in Geographic Information System	3
GM 714	Geodesy and Global Positioning System	3
GM 715	Aerial Photogrammetry	3
GM 716	Regional Geography of Pakistan	3
GM 717	Application of GIS and RS in Project Planning and management	3
GM 718	Application of Geomatics in Applied Geomorphology	3
GM 719	Application of GIS in Infrastructure Development	3
GM 720	Application of Geomatics in Biogeography	3
GM 721	Application of GIS in Disaster Resilience And Recovery	3
GM 722	GIS in Sustainable Tourism Development	3
GM 723	GIS for Agriculture and Food Security	3

LIST OF MINOR/RELATED COURSES

Research Methods

Course Code: GM 701 Credit Hours: 3

Course Content:

Introduction to Research: Definition & Nature, The Scientific Method, The Research Process, and Errors in Research.

Research Design and Data Sources: Types of research and research designs, Primary data and its sources, Secondary data and its sources.

Data Collection Procedures: The Measurement Process, Concepts of validity and reliability, The casual design procedures, Data Collection Methods, Observation, Documentary-Historical Method, The Survey Method

Data Collection Instruments: Questionnaire, Interview and Scheduling, Problems in Data Collection.

Sampling: Sampling Concepts, The Sampling Procedures (Types of Sampling), Determining a sample size & Selection of sample

Data Processing and Analysis: Basic concepts of data processing: Computer representation, Data Matrix,

Data Storage, retrieval and Processing: Editing, Handling Blank Responses, Coding, Categorization, Converting, Weighting, Storing etc., Alternative processing flows, University data analysis, Hypothesis Testing, Bavaria data analysis, Cross- tabulation.

Research Project Proposal: Rationale for the study defining the problem, Research Objectives, Information needs, Research design, Data collection, processing & analysis, Research Team and its profile, Budget, Time Scheduling.

Recommended Literature:

1. Myers, J. L. and Well, A.D. (2002) Research Design and statistical technique. Routledge, London.
2. Maxwell, J.A. (2005) Qualitative research design. Sage Publications, Los Angles.
3. Ranjit Kumar, Research Methodology, Sage Publications.
4. Ingeman Arbonor And Bjoran Berke, Methodology for Creating Business Knowledge, Sage Publications.
5. Dam Remenyl, Doing Research in Business and Management, Sage Publications.
6. David H. Folz, Survey Research for Public Administration, Sage Publications.
7. C. William Emory, Business Research Methods, IRWIN.
8. Clifford, N., Cope, M., Gillespie, T., & French, S. (Eds.). 2016. Key methods in geography (3rd ed.). Los Angeles, CA: SAGE Publications.
9. Cohen, L., Manion, L., & Morrison, K. (Eds.). (2011). Research methods in education (7th ed.). New York, NY: Routledge.
10. Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed methods approaches (4th Eds.). Los Angeles, CA: SAGE Publications.

Geo-Statistics

Course Code: GM 702 Credit Hours: 3

Course Content:

Introduction to Course: Introduction to the course, Sets and Probability, Concept of Random Variables, Possibilities, Probabilities and expectations, Some Rules of Probability, Sampling Theory, Estimation Theory,

Testing Hypothesis: One sample Tests, Two Sample Tests, Regression and Correlation, Analysis of Variance, The Chi- Square Distribution, descriptive statistics, geographic sampling, inferential statistics, correlation, and simple regression. Extensive use is made of geographic examples. The student is required to analyze data both orally and verbally in class assignments. Computer applications in Statistics

Recommended Literature:

1. Jean-Paul, C. and Pierre, D. *(*2003) Geostatistics. John Wiley and Sons, London.
2. Myers, J. L. and Well, A.D. (2002) Research Design and statistical technique. Routledge, London.
3. Maxwell, J.A. (2005) Qualitative research design. Sage Publications, Los Angles.
4. Richard, I. L., (2002) Statistics for Management.
5. Ronald, W. W. (2002) Apportioning historical agricultural statistics using geo-gridded data base elements. Technical memorandum, Amazon.
6. Jean-Paul Chilès, Pierre Delfiner. (2012) Geostatistics: Modeling Spatial Uncertainty, 2nd Edition, ISBN: 978-0-470-18315-1
7. Diggle, Peter, Ribeiro, Paulo Justiniano(2007) Model-based Geostatistics, Springer-Verlag New York
8. Kitanidis, P. (1997). Introduction to Geostatistics: Applications in Hydrogeology. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511626166
9. Richard Webster, Margaret A. Oliver(2007) Geostatistics for Environmental Scientists, 2nd Edition
10. Dimitrakopoulos, R. (2012). Geostatistics for the Next Century: An International Forum in Honour of Michel David's Contribution to Geostatistics, Montreal, 1993, Springer Netherlands. New York, NY : W. H. Freeman : Macmillan Learning

MAJOR COURSES

Geographic Information System: Concepts and Principles

Course Code: GM 703 Credit Hours: 3

Learning Objective: This course focuses on principles, concepts and applications of Geographical Information Systems (GIS): a decision support tool for development planners, social scientists and managers. Database development, manipulation and spatial analysis techniques for information generation will be taught. Students will have the scope of using GIS for applications in their related fields such as natural resource management, environment, civil engineering, infrastructure planning, auditing, monitoring, change detection, modeling, etc will be discussed through projects work and laboratory exercises.

Course Outline: Understanding Geographical Information System, Introduction to Arc GIS, Data Types (Spatial / Aspatial), Data Models & Structures (Raster / Vector), Exploring GIS Dataset in Arc Catalog, Data Sources and Capturing Techniques, Displaying and Manipulating spatial information, Vector Data Preparation (Digitization and Spatial Data Editing), Working on vector data in Arc GIS (Scanning, Digitization and Editing), GPS Survey, Integrating GPS data in GIS Environment, Multidisciplinary Applications of GIS

Recommended Literature:

1. Aronoff, S. (2004) "Geographic Information Systems: A Management Perspective" WDL Publications, Ottawa, Fifth Edition.
2. Clarke, K. (2004) “Getting started with Geographic Information System”, Prentice Hall, New York, Second Edition.
3. Heywood, I., Cornelius, S. and Carver, S. (2003) “An introduction to Geographic Information System”, Addison Wesley Longman, New York, Second Edition.
4. Matt Duckham, Michael F. Goodchild, Michael F. Worboys, (2003) Foundations of Geographic Information Science, Tylor & Francis, NewYork, USA.
5. Michael N. Demers (2002) Fundamentals of Geographic Information System, John Wiley & Sons, Inc., Singapore.
6. K,ang-tsung Chang (2002) Introduction to Geographic Information Systems, McGraw- Hill Company, New York, U.S.A
7. Burrough, P.(2002) “Principles of Geographic Information Systems for Land Resources Management”, Oxford University Press, Oxford, Second Edition.
8. McDonald, R. and Burrough, P. (2001) “Principles of Geographic Information Systems”, Oxford University Press, Oxford.
9. Foresman, T. (1997) “The history of Geographic Information System”, Prentice Hall, New York.
10. Shellito, Bradley A. Discovering. (2017) GIS and ArcGIS New York, NY : W. H. Freeman : Macmillan Learning

REMOTE SENSING

Course code: GM 704 Credit Hours: 3

Learning Objective: This course would help the students to understand that how earth's features are recorded through various sensors. The uses, applications and image processing will also be taught to the students.

Course Outline: Definition and History of Remote Sensing, Physical Basis (EM Spectrum, Energy Interaction, Spectral Reflectance Curves, Image Characteristics) A Study of Sensor Systems (Space and airborne, MSS, TM, ETM, HRV, LISS, IKONOS-2, Quick bird-2, AVHRR and others), Platforms (Types and Orbital Characteristics),Thermal Infrared (Characteristics, TIR Band Properties, TIR Image Interpretation, Introduction to Microwave (Importance and applications), Digital Image Processing (Over view of computer based image processing), Applications (agriculture, urban, natural resources etc.)

Lab Outline: Introduction to lab techniques in Remote Sensing, Single band image interpretation, False color predictions, False color composite Images Interpretation, Visual Interpretation of aerial photographs, Various sensors data comparison, Thermal Infrared Image interpretation, Intro to ERDAS Imagine, display, Geo-linking, Zooming, Identification of targets.
Field Trip to SUPARCO.

Recommended Literature:

1. Lillesand, T. M. and Kiefer, R. W. (2006). Remote Sensing and Image Interpretation, 5th edition. John Wiley and Sons.
2. Mather, P M (2004). Computer Processing of Remotely Sensed Images, 3rd Ed. John Wiley and Sons.
3. Campbell, James B. (2002**.** Introduction to Remote Sensing, 3rd Ed., The Guilford Press.
4. Gibson, P.J (2000). Introductory Remote Sensing: Principles and Concepts. Routledge.
5. Jensen, J. (2000) Remote Sensing of the Environment: An Earth Resources Perspective, Amazon Publishers.
6. Sabins, F.F (1996). Remote Sensing: Principles and Interpretation, 3rd ed, W H Freeman & Co.
7. Campbell, J. B., & Wynne, R. H. (2011). Introduction to remote sensing. Guilford Press.
8. Rees, G., & Rees, W. G. (1999). The remote sensing data book. Cambridge university press.
9. Barrett, E. C. (2013). Introduction to environmental remote sensing. Routledge.
10. Rees, W. G. (2005). Remote sensing of snow and ice. CRC press.

FUNDAMENTALS OF GEOGRAPHY

Course Code: GM 705 Credit Hours: 3

Learning Objective: This course attempts to impart the knowledge of physical geography including lithosphere, atmosphere and hydrosphere. This course also provide the relationship between man and environment including the distribution of population, human settlements, resources and related human activities.

Course Outline: Scope and status of physical Geography, The basic concept and theories in physical Geography including theory of continental drift, plate tectonics and peneplain concept.

Scope and Status of human Geography, Concepts and theories including Environmental determinism, Possibilism, Probabilism and cognitive behaviorism. Population:
Population distribution, density and growth. Population change including migration, Population composition and Structure. Factors of Landform Development, Weathering and Mass Wasting, Fluvial morphology, Desert Landforms, Glaciers and their topographic effects, Karsts topography, Soil Development. Factors and elements of weather and climate, Composition and structure of atmosphere, Horizontal and vertical distribution of temperature, The distribution of pressure and seasonal variations, Wind Circulation, Humidity and forms of condensation, Classification of Climate.
Origin of oceans and seas, Floor of oceans - Characteristic features of the ocean basins, temperature, salinity distribution, causes and effects, Oceanic circulation: Waves, currents and tides, their nature, causes and effects and impact on man and the environment.
Human Activities, Natural resources, their distribution and utilization: Renewable and non-renewable resources, Human Settlements, Theories of urban structure, settlement pattern, City-Size, Distribution, Rank-Size Rule, Primate Cities.
Lab Outline: Identification of rocks and minerals, Study and identification of landforms using air photos and General topographic sheet, soil and water analysis. Use and making of various models showing various types of landforms, Recording and observation of weather data from a mini weather station, Identification of cloud types, Drawing of World map showing the origin of continents and oceans.
Field visits:

- Ground truthing and study of rock types, fluvial, glacial and desert landforms to identify the various types of soil, identification of landforms in limestone topography.
- Visit to the coastal area to observe and appreciate the characteristic of coastal features.
- Visit to Soil Survey of Pakistan, Geological survey of Pakistan, Meteorological station/observatory and National Institute of Oceanography.

Recommended Literature:

1. Strahler, A.N. (2004) “Modern Physical Geography” New York: John Wiley.
2. Gabler, R.E, Sager, R.J and Wise, D.L (1997). Essentials of Physical Geography, Fourth Edition. Saunders College Publishing, New York.
3. Scott, R.C (1996) Introduction to physical geography, West Publishing Co, New york.
4. Miller, G.T (1996) Living in the Environment, Principles, connections and solutions, Ninth Edition, Wadsworth.
5. Thurman, H.V. & Mexrill (1996) “Essentials of Oceanography” Menson, London.
6. Diwan A.P. & D.K. Arora (1995) “Origin of the Ocean” Anmol Publisher, Delhi.
7. Rowntree, L. et .al (2004) “Globalization and Diversity: Geography of a Changing World” Prentice Hall, New York
8. Neuwirth, R. (2004) “Shadow Cities: A Billion Squatters, A New Urban World” Routledge, London.
9. Harper, H.L. (2003) “Environment and Society: Human Perspectives on Environmental Issues” Prentice Hall; (3 Edition)
10. Knox, P.L. & S.A. Marston (2003) “Places and Regions in Global Context: Human Geography” Prentice Hall. (3rd Edition)
11. Becker, A. & Secker (2002) “Human Geography: Culture, Society, and Space” John Wiley and Sons. (7th Edition)

12. Blij, H.J.D. (2002) “Human Geography: Culture, Society, and Space” John Wiley and Sons (7th Edition)
13. Lewis, C.P. Mitchel-Fox & C. Dyer (2001) “Village, Hamlet and Field: Changing Medieval Settlements in Central England” Windgather Press.
14. Hagget, P. (1997): “Geography: A Modern Synthesis” Harper International, London

MAPPING AND SURVEYING

Course Code: GM 706 Credit Hours: 3

Learning Objectives: The purpose of this course is to familiarize the students with mapping and surveying. They will also be made aware of the theory and practical field skills.

Course Outline: Overview of surveying, objects and classification of surveying, scales, survey tasks, survey principles and methods, accuracy and precision, measurement and errors, coordinate systems and computation, direct distance measurements, errors in measurement of distance and corrections, height measures, leveling and its types, bench marks, leveling staff, sources of errors in leveling and accuracies, angular measurements, reading systems of optical theodolites, measuring angles and adjustments, indirect distance measurements, contouring plans by level and staff, section and cross-sections, precise and reciprocal leveling, traverse survey, triangulation and trilateration, GPS survey. Principles of GPS**,** GPS Segment, Receiver Position, Velocity, and Time, Carrier Phase Tracking (Surveying), GPS Satellite Signals, GPS Error Sources, Differential GPS Techniques, GPS Techniques.

Lab Outline: Instrumental surveys will be included for measuring the distance, angles and heights. Major emphasis will be towards theodolite and leveling surveys, Digital Total Station.

Recommended books:

1. Wolf P R., Ghilani C, (2005) Elementary Surveying: An Introduction to Geomatics ,11th Edition, Prentice Hall, USA.
2. Michael Kennedy (2002), “The Global Positioning System and GIS: An Introduction” 2nd Edition, Taylor & Francis, New York.
3. Paul Zarchan (1996), “Global Positioning System: Theory and Application, Volume I, American Institute of Aeronautics and Austronautics, Inc., Washington DC.
4. Heywood, I., Cornelius, S. and Carver, S. (1999) “An introduction to Geographic Information System”, Addison Wesley Longman, New York, second edition.
5. Aronoff, S**. (**2004) "Geographic Information Systems: A Management Perspective", WDL Publications, Ottawa, Canada, Forth edition.
6. Anderson, J. M., Mikhail E. M., (1998), Surveying Theory and Practice, 7th Ed., MCB/McGraw-Hill, US.
7. Wirshing R., Wirshing R. J., (1985), Schaum's Outline of Introductory Surveying, McGraw-Hill, UK.
8. McCormac J. C., McCourmac J. C., Anderson W., (1999), Surveying, 4th Edition, Wiley, UK.

SPATIAL DATA MODELING

Course Code: GM 707 Credit Hours: 3

Learning Objectives: This course attempts to provide understanding of spatial analysis, concepts, spatial analysis skills, within GIS environment. Techniques will include the application of spatial analysis in physical, social, engineering, earth and biological sciences.

Course Outline: Introduction, characteristics and potentials of spatial data; Spatial Analysis, Point pattern and analysis, Lines and networks development and analysis, Area objects and spatial autocorrelation, types of area objects, Geometric properties of areas, Boundary Analysis, Buffering and neighborhood function, Proximity Analysis, Neighborhood Analysis, Modeling and storing field data, Spatial interpolation, Derived measures on surfaces, map overlays, Vector and raster overlay operations, Problems in simple Boolean polygon overlay, Multivariate data, multidimensional space**,** Multivariate data and multidimensional space, Distance, difference and similarity, Cluster analysis, PCA, New approaches to spatial analysis, Interpolation techniques, surface modeling, DTM/DEM, Multi-criteria and Multi-attribute Modeling, Uncertainties in spatial modeling.

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

Recommended Literature:

1. David O' Sullivan and David J. Unwin (2003) "Geographic Information Analysis", John Wiley & Sons, Inc., Canada.
2. Chang, Krang-tsung (2002) "Introduction to Geographic Information Systems" McGraw Hill.
3. David L. Verbyla (2002) "Practical GIS Analysis". Taylor & Francis, London.
4. Donald P. Albert & Wilbert M. Gesler (2000) "Spatial Analysis, GIS and Remote Sensing Application in Health Sciences" Ann Arbor Press, Michigan, USA.
5. John Stillwell & Graham Clarke (2004) "Applied GIS and Spatial Analysis", John Wiley & Sons, UK.
6. Peter M. Atkinson and Nicholas J. Tate (1999) "Advances in Remote Sensing and GIS Analysis" John Wiley & Sons, UK.
7. Heywood, I., Cornelius, S. and Carver, S.(1999) "An introduction to Geographic Information System", Addison Wesley Longman, New York, second edition.
8. Paul, L., Michael, G., David, M. & David, R.(1999) "Geographic Information Systems: Principles, Techniques, Applications and Management". John Wiley & sons.
9. Nicholas, C. (1997) "Exploring Geographic Information System". John Wiley & sons, UK.
10. Robert, L., Derek, T. (1992) "Fundamentals of Spatial Information Systems". Academic Press.
11. Hristopulos, D. T. (2020). Random fields for spatial data modeling: a primer for scientists and engineers. Springer Nature.

1. Moraga, P. (2019). Geospatial health data: Modeling and visualization with R-INLA and shiny. Chapman and Hall/CRC.

12. Samet, H. (1990). The design and analysis of spatial data structures (Vol. 85, p. 87). Reading, MA: Addison-Wesley.
13. Christensen, R. (1991). Linear models for multivariate, time series, and spatial data (Vol. 1). New York: Springer-Verlag.
14. Shi, W. (2009). Principles of modeling uncertainties in spatial data and spatial analyses. CRC press.
15. Banerjee, S., Carlin, B. P., & Gelfand, A. E. (2003). Hierarchical modeling and analysis for spatial data. Chapman and Hall/CRC.

GEODATABASE AND PROGRAMMING

Course code: GM 708 Credit Hours: 3

Learning Objectives: Introduction to Database and Geodatabase, Integration of Data into Geodatabase Topology, Subtypes and Attribute Domains, Relationship Classes and Geometric Networks, UML and CASE Tools for Geodatabase, Overview of Visual Basic, Understanding Map Objects, Maps and Layers Controls, Coordinates and Map Projections, Geometrics, Map Display and Features Rendering, Data Access and Control, Address Matching, Application Deployment

Recommended Literature:

1. Bruce Ralston (2002) Developing GIS Solutions with Map Objects and Visual Basic Onward Press, Thomson Learning, New York.
2. Kang-Tsung Chang Programming **(**2005) ArcObjects with VBA: A Task-Oriented Approach, CRC Press LLC.
3. Philippe Rigaux, et al (2002) Spatial Databases: With Application to GIS (Morgan Kaufmann Series in Data Management Systems) Academic Press, U.S
4. Menno-Jan Kraak (2001) Web Cartography, Taylor & Francis
5. Simon W. Houlding (2000) Practical Geostatistics: Modeling and Spatial Analysis (with CD-ROM) Springer; Bk&CD Rom edition
6. Zeiler, M. (1999). Modeling our world: the ESRI guide to geodatabase design (Vol. 40). ESRI, Inc..
7. Nasser, H. (2014). Learning ArcGIS Geodatabases. Packt Publishing Ltd.
8. Butler, J. A. (2008). Designing geodatabases for transportation. ESRI, Inc..
9. Chang, K. T. (2007). Programming ArcObjects with VBA: a task-oriented approach. CRC Press.
10. Briner, A. P., Kronenberg, H., Mazurek, M., Horn, H., Engi, M., & Peters, T. (1999). FieldBook and GeoDatabase: tools for field data acquisition and analysis. Computers & Geosciences, 25(10), 1101-1111.

DIGITAL CARTOGRAPHY

Course code: GM 709 Credit Hours: 3

Learning Objectives: This course would provide 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 Cartography, Nature of Cartography, Map Types. History of Cartography, Map Symbols, Lettering, Scale and direction, Geodesy, Coordinate systems, Map Projections Graphical and datum, Map Projections Mathematical. Perspective, non-perspective, conventional, Generalization, Thematic Maps, Descriptive Statistics, Class Intervals, Choropleth Maps, Proportional Symbol Maps, Dot Maps, Cartograms, Flow Maps, Graduate Colour Maps, Map Compilation, Map Design, Cartography and Ethics, Map Production. Development of skills for Computer Software applications for graphics drawing and statistical mapping capabilities.

Lab Outline: Map reading, Assignment on Types of Maps, Understanding of survey of Pakistan symbology and Development of Symbol 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 Literature:

1. Slocum, R. M., Fritz, K., and Hugh, H. (2004) Thematic Cartography and Geographic Visualization, 2nd Edition, Terry.
2. Robert G. Cromley (2003) “Digital Cartography”. Prentice Hall Inc.
3. M.J. Kraak & F.J. Ormeling, (1996) “Cartography- Visualization of Spatial Data.” Addison Wesley Longman Limited.
4. 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.
5. Cartography, Visualization of Spatial Data (2002) 2nd Edition, Menno-Jan Kraak, Ferjan Ormeling.
6. Amazon (1988), Cartography with ArcView GIS and Map Projection, 5th Edition.
7. Amazon (1988), Cartography: Thematic Map Design, 5th Edition.
8. Amazon (1999) Multimedia Cartography, 1st Edition.
9. Ehrenberg, R. E. (2005) “Mapping the world: An illustrated history of cartography”. National Geographic.
10. Maginr, D. J. (1991) “Geographic Information System”. Longman, London.
11. Jobst, M. (Ed.). (2010). Preservation in digital cartography: archiving aspects. Springer Science & Business Media.
12. Clarke, K. C. (1995). Analytical and computer cartography. Englewood Cliffs, NJ: Prentice Hall.
13. Muehlenhaus, I. (2013). Web Cartography. Boca Raton: CRC Press.
14. Caquard, S. (2009). Foreshadowing contemporary digital cartography: A historical review of cinematic maps in films. The Cartographic Journal, 46(1), 46-55.
15. Monmonier, M. S. (1985). Technological transition in cartography. In Technological transition in cartography.. University of Wisconsin Press.

DIGITAL IMAGE PROCESSING

Course Code: GM 710 Credit Hours: 3

Learning Objectives: This course aims at providing students with advanced Remote Sensing analytical techniques required in various applications; how to extract high-level information from RS data. In this course the student will be exposed to advanced digital image processing and their applications in visible, thermal and microwave remotely sensed data sets.

Course Outline: In depth understanding of image processing, analysis and interpretation. Topics include human vision and colour, the construction, arithmetic operations, empirically based image transformations, filtering of images, discrete Fourier transformations, principal components analysis, and spatial modeling, advanced image classifications such as fuzzy classifications, neural classifiers, spatial and spectral segmentation, sub pixel classification. SAR interferometry, applications of SAR interferometry, image spectrometry, Feature Extraction from Hyperspectral data, Image Residuals, Spectral Fingerprints, Absorption-band Parameters, Spectral Derivative Ratio, Classification Algorithms for Hyperspectral Data, radar remote sensing, speckle noise and suppression, texture analysis, data Fusion, DEM extraction from stereo SAR. Computer-based exercises are an essential part of this course.

Recommended Literature:

1. Mather, P (2004). Computer processing of remotely sensed images. John Wiley and sons, London.
2. David A Landgrebe (2003) Signal Theory Methods in Multispectral Remote Sensing **(**Wiley Series in Remote Sensing and Image Processing**)** Wiley-Interscience, London.
3. Campbell, James B. (2002) Introduction to Remote Sensing, 3rd Ed., (The Guilford Press)
4. Henderson, F.M and Lewis, A.J (1998). Principles and applications of Imaging Radar. Manual of Remote Sensing, Third Edition Volume 2. John Wiley and Sons.
5. Peebles, P.Z (1998), Radar Principles, Wiley Inter science, New York.
6. Elachi, C. (1988): Spaceborne Radar Remote Sensing: Applications and Techniques, IEEE Press, New York.
7. Roger M. McCoy (2004) Field Methods in Remote Sensing The Guilford Press
8. Walter G. Egan, Walter Egan (2003) Optical Remote Sensing: Science and Technology (Optical Engineering) Marcel Dekker
9. Fawwaz T. Ulaby (1986), Microwave Remote Sensing: Active and Passive, Volume I: Fundamentals and Radiometry (March, Artech House Publishers.
10. Fawwaz Tayssis Ulaby (1986) Microwave Remote Sensing: Active and Passive, Volume II: Radar Remote Sensing and Surface Scattering and Emission Theory Artech House Publishers.
11. Solomon, C., & Breckon, T. (2011). Fundamentals of Digital Image Processing: A practical approach with examples in Matlab. John Wiley & Sons.
12. Niblack, W. (1985). An introduction to digital image processing. Strandberg Publishing Company.
13. Baxes, G. A. (1994). Digital image processing: principles and applications. John Wiley & Sons, Inc..
14. Annadurai, S. (2007). Fundamentals of digital image processing. Pearson Education India.
15. Tyagi, V. (2018). Understanding digital image processing. CRC Press.

SPATIAL DECISION SUPPORT SYSTEMS

Course Code: GM 711 Credit Hours: 3

Learning Objectives: The overall aim of this course is to provide the students with an understanding of decision support system and with the development of decision support systems.

Course Outline: Decision Making Processes: Introduction, Major decision-making Paradigms, Models of decision-making, Different types of problem, Hierarchy of decisions, Spatial Decision-Making: Introduction, A systematic approach for solving spatial problems, Methods and techniques to support spatial decisions, Performance modeling and types of criteria, Measurement Scales, Uncertainty in decision making process Decision Support Systems: Introduction, Origin, Definition and components, Fundamental Phases, Characteristics and Capabilities of DSS, GIS and Decision Support Systems, Spatial Decision Support Systems, Integration of GIS and DSS Multi-criteria Evaluation: Criteria properties, Criteria weighting, Pair wise comparison, Ranking techniques, Rating techniques, Sensitivity analysis, Redistribution criteria weight, Option Ranking methods, Weighted summation, Ideal point, Rank order Methods and Tools for Collaborative Decision- Making: Introduction, Task Analysis as a Needs Assessment, System Requirement Analysis, Software Capabilities, Collaboration Personnel, Example Configurations for Same Place – Same Time Collaboration, Architectures for Implementing Collaborative Decision Support Systems, Hardware Architecture for Same-Place, Same-Time Collaboration Support, Software Architecture for Same- Place, Different-Time Collaboration Support, Hardware Architecture for Different-Place, Same-Time Collaboration Support, Software Architecture for Different-Place, Different-Time Collaboration Support, Existing DSS Supported Collaborative Decision -Making Software Packages, INDEX®, Smart Places Series E, Active Response GIS, Geo Choice PerspectiveTM , Consensus Evaluation, Conflict Analysis, Identification of Stakeholders, Identification of Options, Identification of Interest (criteria), Mediation and Negotiation Approaches, Facilitation, Consensus Evaluation

Lab Outline: Populating a data warehouse using different loading facilities, running different queries for extraction of results. Populating and using an OLAP tool.

Recommended Literature:

1. Turban, A . E. and J. Aronson (1998), Decision Support Systems and Intelligent Systems, 5th edition, Prentice Hall.
2. Mark, L.G. (2005) Fundamentals of database management system. John Wiley, and sons, London.
3. Heywood, I., Cornelius, S. and Carver, S. (2003) "An introduction to Geographic Information System", Addison Wesley Longman, New York, Second Edition.
4. Sauter, B. V. (1997) Decision Support Systems. John Wiley & sons, Inc.
5. Sugumaran, R., & Degroote, J. (2010). *Spatial decision support systems: principles and practices*. Crc Press.
6. Keenan, P. B. (2003). Spatial decision support systems. In Decision-making support systems: Achievements and challenges for the new decade (pp. 28-39). IGI Global.
7. Power, D. J. (2007). A brief history of decision support systems. DSSResources. com, 3.
8. Keenan, P. B., & Jankowski, P. (2019). Spatial decision support systems: Three decades on. Decision Support Systems, 116, 64-76.
9. de Lima, L. M. M., de Sá, L. R., dos Santos Macambira, A. F. U., de Almeida Nogueira, J., de Toledo Vianna, R. P., & de Moraes, R. M. (2019). A new combination rule for Spatial

Decision Support Systems for epidemiology. International journal of health geographics, 18(1), 1-10.
10. Malczewski, J. (1999). Visualization in multicriteria spatial decision support systems. Geomatica, 53(2), 139-147.

INTEGRATED LAND AND WATER INFORMATION SYSTEM

Course Code: GM 712 Credit Hours: 3

Learning Objectives: To train students in Integrated Land and Water Information System in GIS environment, and practical exercises in preparation, integration and analysis of geo-spatial data.

Course Outline: Introduction to Integrated Land and Water Information System in GIS, Displaying geographic data, Structure of spatial data in GIS softwares, Displaying maps and Layer management, domains, coordinates, representation and table, Attribute data, pixel information, spatial data input, spatial data management, Attribute data handling, Image processing, spatial and non-spatial data imports, Spatial data analysis, retrieval, classification and measurement operations, Spatial data analysis, overlay operations, spatial data analysis, neighborhood and connectivity operations, Using digital Elevation Models, geostatistical tools, Presentation of results.

Recommended Literature:

1. ITC (2001) ILWIS Academic User's Guide. International Institute for Aerospace Survey and Sciences, Netherland.
2. Aronoff, S. (2005) Remote Sensing for GIS Managers. ESRI Press, New York.
3. ITC (2002) ILWIS Application Guide. International Institute for Aerospace Survey and Sciences, Netherland.
4. Maginr, D. J. (1991) Geographic Information System. Longman, London.
5. Hengl, T., Maathuis, B. H. P., & Wang, L. (2009). Geomorphometry in ILWIS. Developments in Soil Science, 33, 309-331.
6. Meijerink, A. M. J. (1990). Summary report on ILWIS development. ITC journal, (3), 205-214.
7. Hengl, T., Gruber, S., & Shrestha, D. P. (2003). Digital terrain analysis in ILWIS. International Institute for Geo-Information Science and Earth Observation Enschede, The Netherlands, 62.
8. Nijmeijer, R., A. de Haas, R. J. J. Dost, and P. E. Budde. "ILWIS 3.0 Academic: user's guide." (2001).
9. Sensing, S. R., & GIS, I. (2001). ILWIS 3.0 Academic.
10. Van Westen, C. J., Alkema, D., Damen, M. C. J., Kerle, N., & Kingma, N. C. (2011). Multi-hazard risk assessment. United Nations University–ITC School on Disaster Geoinformation Management.

MODELING IN GEOGRAPHICAL INFORMATION SYSTEM

Course Code: GM 713 Credit Hours: 3

Learning Objectives: This course will familiarize students with modeling in GIS such as spatial database accuracy assessment, spatial analysis, Digital Elevation and Terrain modeling, 2D and

3D spatial modeling. Students will be trained to develop models based on regression analysis and logical analysis.

Course Outline: Introduction to modeling in GIS, Co-ordinate System and Map Projection, Drawing of Map Projections and Error Estimations, Understanding of Cartographic Errors and Rectification Procedures, Cleaning and Editing Cartographic Data Visualization of Geospatial Data, Symbolization and Map Layouts Development, 3D Visualization of Spatial Data, Alternate Approaches for Mapping (Geocoding, Survey Data Integration), Geocoding and Survey Data Integration in GIS, Point Pattern Analysis, Lines and Networks, Performing Network Analysis, Area Objects and Spatial Autocorrelation, Describing and Analyzing Fields, Spatial Interpolations, Geostatistical Analysis, Map Overlay Analysis, Multivariate Data, Multidimensional Space and Spatialization, GIS Modeling and Related Issues.

Recommended Literature:

1. John Stillwell (2004) Applied GIS and Spatial Analysis John Wiley & Sons, Ltd. England
2. Aronoff, S. (2004) "Geographic Information Systems: A Management Perspective", WDL Publications, Ottawa, Fifth Edition.
3. Clarke, K. (2004) “Getting started with Geographic Information System”, Prentice Hall , New York, Second Edition.
4. Heywood, I., Cornelius, S. and Carver, S. (2003) “ An introduction to Geographic Information System”, Addison Wesley Longman, New York, Second Edition.
5. Burrough, P.(2002) “Principles of Geographic Information Systems for Land Resources Management”, Oxford University Press, Oxford, Second Edition.
6. McDonald, R. and Burrough, P. (2001) “Principles of Geographic Information Systems”, Oxford University Press, Oxford, Second Edition
7. Foresman, T. (1997) “The history of Geographic Information System”, Prentice Hall, New York.
8. Stewart Fotheringham, Chris Brunsdon, Martin E Charlton (2000) Quantitative Geography: Perspectives on Spatial Data Analysis SAGE Publications.
9. Jacek Malczewski (1999) GIS and Multi-criteria Decision Analysis John Wiley & Sons, Inc.
10. Martien Molenaar (1998) An Introduction to the Theory of Spatial Object Modeling for GIS Taylor & Francis, Inc.
11. Pinder, G. F. (2002). Groundwater modeling using geographical information systems. John Wiley & Sons.
12. Sharma, H. S., Prasad, R., & Binda, P. R. (2006). Mathematical modelling in geographical information system, global positioning system and digital cartography. Concept Publishing Company.
13. Heppenstall, A. J., Crooks, A. T., See, L. M., & Batty, M. (Eds.). (2011). Agent-based models of geographical systems. Springer Science & Business Media.
14. Burrough, P. A., McDonnell, R. A., McDonnell, R., & Lloyd, C. D. (2015). Principles of geographical information systems. Oxford university press.
15. Mainguenaud, M. (1995). Modelling of the geographical information system network component. *International Journal of Geographical Information Systems*, *9*(6), 575-593.

GEODESY AND GLOBAL POSITIONING SYSTEM

Course Code: GM 714 Credit Hours: 3

Learning Objectives: This course attempts to provide training on the various aspects of GPS, GPS coordinates, tracking, mapping, measurements and their corresponding accuracies and its uses in the identification and taking of ground control points.

Course Outline: Principles of GPS**,** US Department of Defense Satellite Navigation System, Space Segment, Control Segment, User Segment, GPS Positioning Services Specified In the Federal Radio Navigation Plan, Precise Positioning Service, Standard Positioning Service, GPS Data, Position and Time from GPS, Code Phase and Pseudo-Range Navigation, Receiver Position, Velocity, and Time, Carrier Phase Tracking (Surveying), GPS Satellite Signals, GPS Error Sources, Differential GPS Techniques, Differential Code-Phase Navigation, Differential Carrier-Phase Surveying, Common-Mode Time Transfer, GPS Techniques and Project Costs, Exploration of Advance System as Differential GPS.

Lab Outline: GPS value reading, Easting Northing & elevation, Map Projections and Datum Settings, GPS based surveys, tracking and data processing, horizontal & vertical errors calculations, GPS Project

Recommended Literature:

1. Michael Kennedy (2002), "The Global Positioning System and GIS: An Introduction" 2nd Edition, Taylor & Francis, New York.
2. Paul Zarchan (1996), "Global Positioning System: Theory and Application, Volume I, American Institute of Aeronautics and Austronautics, Inc., Washington DC.
3. Heywood, I., Cornelius, S. and Carver, S. (1999) "An introduction to Geographic Information System", Addison Wesley Longman, New York, second edition.
4. Aronoff, S**. (**2004) "Geographic Information Systems: A Management Perspective", WDL Publications, Ottawa, Canada, Forth edition.
5. GPSCO (1992). Getting started with GPS Surveying .GPSCO Land Information centre, NSW, Australia.
6. Strang G., & Borre, K. (1997). Linear algebra, geodesy, and GPS. Siam.
7. 7 Wells, D., Beck, N., Kleusberg, A., Krakiwsky, E. J., Lachapelle, G., Langley, R. B.& Delikaraoglou, D. (1987). Guide to GPS positioning. In Canadian GPS Assoc.
8. Strang, G., & Borre, K. (1997). Linear algebra, geodesy, and GPS. Siam.
9. Hofmann-Wellenhof, B., Lichtenegger, H., & Collins, J. (2012). Global positioning system: theory and practice. Springer Science & Business Media.
10. Xu, G. (Ed.). (2010). Sciences of geodesy. Springer.
11. Xu, G., & Xu, Y. (2007). GPS. Springer-Verlag Berlin Heidelberg.

AERIAL PHOTOGRAMMETRY

Course Code: GM 715 Credit Hours: 3

Learning Objectives: This course attempts to provide concepts of key elements of photogrammetry such as cameras, aerial photographs, principles, Grey scale, techniques of measuring 2 D and 3 D objects, stereophotogrammetry and its applications.

Course Outline: Introduction to photogrammetry, history and Overview, Analog, analytical, and digital photogrammetry, Photogrammetric cameras, Review of data acquisition and single

photograph properties, Spatial measurement and scale calculation, Problems with aerial photograph and rectification of a single aerial photograph, Aerial Photograph Interpretation, Types of Aerial Photograph and mosaics, Stereoscopic Analysis DEM generation, Orthophotography/ Orthoimage, applications.

Lab Outline: Introduction, Comparison of formats**,** Sensor, films and filters, Data acquisition methods, Area and scale measurement, Parallax and radial displacement, Visual interpretation of aerial photographs, vertical air photos, Mirror stereoscopic interpretation, Ortho-rectification, case studies.

Recommended Literature:

1. Sabins S.F (2000). Remote Sensing: Principles and Interpretation, Third Edition. Freeman and Company, New York.
2. Lo, C.P (1986). Applied Remote Sensing (Longman).
3. Philipson, W.R (1997) Manual of Photographic Interpretation (2nd edition) (American Society for Photogrammetry and Remote Sensing).
4. Colwell, R.N (ed.) (1983) Manual of Remote Sensing Second Edition in 2 volumes (American Society of Photogrammetry)
5. Kochi, N. (2017). Photogrammetry. In Handbook of Optical Metrology (pp. 555-582). CRC Press.
6. Wolf, P. R., Dewitt, B. A., & Wilkinson, B. E. (2014). Elements of Photogrammetry with Applications in GIS. McGraw-Hill Education.
7. Egels, Y., & Kasser, M. (2001). Digital photogrammetry. CRC Press.
8. Li, Z., Chen, J., & Baltsavias, E. (Eds.). (2008). Advances in photogrammetry, remote sensing and spatial information sciences: 2008 ISPRS congress book (Vol. 7). CRC Press.
9. Trorey, L. G. (1950). Handbook of aerial mapping and photogrammetry. CUP Archive.
10. Linder, W. (2013). Digital photogrammetry: theory and applications. Springer Science & Business Media.

REGIONAL GEOGRAPHY OF PAKISTAN

Course Code: GM 716 Credit Hours: 3

Learning Objectives: The making and Genesis of Pakistan, Geopolitical situation and related problems, The Land: Physiography and physiographic regions, Climate and Climatic regions, Vegetation and Soils. The People and Economy: Population, Agriculture and Irrigation, Power and Mineral resources, Industries, Urbanization, Communication and Trade. Pakistan and the World: Pakistan's neighbors, Pakistan and the Muslims Countries, Pakistan and the Great Power, Pakistan and the third World Countries.

Recommended Literature:

1 Anwar, M.A. (1998) Geography of Pakistan. White Rose publishers and book seller, Lahore.
2 Khalid, A. K. (2005) Geography of Pakistan. Career books publisher, Lahore.
3 Khan, F. K. (2002) A Geography of Pakistan. Oxford University Press, Karachi.
4 Burkey, J. S. 1991. Pakistan the continuing search for Nationhood. Western Press, Oxford, UK.
5 GOP (1993) Environmental Profile of Pakistan and NWFP. Ministry of environment, Islamabad.

6 Spate, O. H. K., & Learmonth, A. T. A. (2017). India and Pakistan: A general and regional geography. Routledge.
7 Roger, M. (2017). Regional geography: Theory and practice. Routledge.
8 Hobbs, J. J. (2016). Fundamentals of world regional geography. Cengage Learning.

APPLICATION OF GIS AND REMOTE SENSING IN PROJECT PLANNING AND MANAGEMENT

Course Code: GM 717 Credit Hours: 3

Learning Objectives: This course attempts to cover important aspects of different types of project planning including development planning and business projects etc. The course covers various topics starting from basic concepts and problems relating to projects, project planning and project managers.

Course Outline: Overview of the course, project planning and management**,** project organization, project selection, models and techniques, Project planning, Planning process/cycle, Project appraisal, Cost Benefit analysis, project scheduling, project monitoring, reporting and project termination.

Recommended Literature:

1. Merideth, J.R., Sammuel, J. Manbel. (1989) Project Management, New York, John Wiley.
2. Mark, L.G. (2005) Fundamentals of database management system. John Wiley, and sons, London.
3. Choudhry, S. Taha, (2000) Project Management, India, McGraw Hill.
4. LittleI.M.D., Mirrlees, J.M. (1982) Project Appraisal and Planning for Developing Countries, India, Oxford and IBH.
5. Sample, A. (Ed.). (1994). Remote sensing and GIS in ecosystem management. Island Press.
6. Köhl, M., Magnussen, S., & Marchetti, M. (2006). Sampling methods, remote sensing and GIS multiresource forest inventory (p. 373). Berlin: Springer.
7. Schultz, G. A., & Engman, E. T. (Eds.). (2012). Remote sensing in hydrology and water management. Springer Science & Business Media.
8. Skidmore, A. (2017). Environmental modelling with GIS and remote sensing. CRC Press.
9. Albert, D. P., Gesler, W. M., & Levergood, B. (Eds.). (2000). Spatial analysis, GIS and remote sensing: Applications in the health sciences. CRC Press.
10. Helldén, U. (1987). An assessment of woody biomass, community forests, land use and soil erosion in Ethiopia. A feasibility study on the use of remote sensing and GIS [geographical information system]-analysis for planning purposes in developing countries. Lund University Press.

APPLICATION OF GEOMATICS IN GEOMORPHOLOGY

Course Code: GM 718 Credit Hours 3

Learning Objectives: This course is based on the application of advance tool (GIS/RS) and geomorphological concepts. The main emphasis is to train the students to use advance tools GIS/RS in identification and recognition of geomorphic processes, their causes and impacts on human being.

Course contents:

1. Introduction to Applied Geomorphology
   - a Scope and Importance
   - b Geomorphology and Environment
   - c Geomorphic Change and Man
2. Monitoring Geomorphological Changes in the Environment
3. Endogenic Hazards
   - a. Earthquakes & Volcanicity: Cause, Morphotectonics and Earthquake, Prediction, Damages, Earthquake Hazards Zoning, Environmental Management and Earthquakes, Volcanoes
   - b. Hydrological Hazards
   - c. Rivers and Flood Plains, Flooding, Drainage Basin System, Sediment Load and Budgets, Drainage Basin/Watershed Management
   - d. Drought, Types and Resources, Hydrological Drought
   - e. Glacial and Periglacial Environment, High-latitude and High altitude Problems. Glacial Hazards, Periglacial Hazards, Aggradation and Degradation, Forest Hazards, Snow as a Hazard to the Urban System.
4. Application of Geomatics in Environmental Hazards
   - a. Application of Geomatics in Soil Erosion by Water and Wind, Nature and Types of Soil Erosion, Raindrop Erosion, Run-off Erosion, Aeolian Erosion, Economic and Productivity Implication
   - b. Application of Geomatics in Weathering of Rocks and Stones, Causes, Implication
   - c. Application of Geomatics in Desertification, Causes and Implication
   - d. Application of Geomatics in Mass Movement Hazards, Concept, Classification, Causes, Snow Avalanches and Associated Problems.
5. Application of Geomatics in Mapping Geomorphology
   - a. Techniques of Geomorphological Mapping
   - b. Data Sources for Mapping
6. Application of Geomatics in Geomorphology and Environmental Management
   - a. Geomorphology in Planning and Decision Making
   - b. National Conservation Strategy in the context of Geomorphology.

Recommended Literature:

1. Shit, P. K., Pourghasemi, H. R., & Bhunia, G. S. (Eds.). (2020). Gully erosion studies from India and surrounding regions. Springer International Publishing.
2. Anbazhagan, S., Subramanian, S. K., & Yang, X. (Eds.). (2011). Geoinformatics in applied geomorphology. CRC Press.

3. Piacentini, T., & Miccadei, E. (2012). Studies on environmental and applied geomorphology. InTech.
4. Smith, M. J., Paron, P., & Griffiths, J. S. (2011). Geomorphological mapping: methods and applications (Vol. 15). Elsevier.
5. Cooke, R. U. & J. C. Doornkamp (1990): Geomorphology in Environmental Management (New Edition). Clarendon Press Oxford.
6. Amalkar, K.Sen & (1993): Desertification and its control in the Thar, Sahara and Sahel Regions. Scientific Publishers, Jodpur, India.
7. Donald A. W. et al (1987): Planning for Drought: Reduction of Societal Vulnerability. West View Press, London.
8. Foster H. D (1980): Disaster Planning: The prevention of life and property. Springer Press Berlin.
9. GoP (1992) Pakistan National Conservation Strategy. Environment and Urban Affairs Division Islamabad.
10. Burtan, et al (1978): The Environment as Hazard. Oxford University Press, London.
11. Knapp, B. (1989): Challenge of the Natural Environment. Longman, New York.
12. Alexander D. (1993): Natural Disaster. UCL Press.
13. Hart, M.G. (1986): Geomorphology Pure and Applied. George Allen & Unwin, London.
14. Anbazhagan, S., Subramanian, S. K., & Yang, X. (Eds.). (2011). Geoinformatics in applied geomorphology. CRC Press.

APPLICATION OF GIS IN INFRASTRUCTURE DEVELOPMENT

Course Code: GM 719 Credit Hours 3

Course Contents:

1. Infrastructure Planning for Sustainable Cities;
    a) Linking Urban Planning, GIS and Infrastructure Network Planning
        - Life Cycle /Demand –Capacity Approach to infrastructure Network Planning
        - Demand Capacity Analysis and life Cycle Planning
    b) Life cycle infrastructure planning
2. The Nature of Infrastructure Projects;
    a) Concept of infrastructure
    b) Types of physical infrastructure
        - Social Infrastructure
        - Trade Infrastructure
        - Technical (Economic Infrastructure)
    c) Infrastructure development
       Infrastructure development stages
        - Planning stage
        - Design Stage
        - Construction stage
        - Operational stage
        - Recycling and disposal stage
    d) Toward a service focused approach
3. Determination and Selection of Sites for Infrastructure Development

a) The policy framework
- Environment
- Goals and objectives
- Knowledge, information and communication
- Resource
- Institutions

b) Determinants of public and private infrastructure using GIS/RS
- Site suitability analysis
- Major components of infrastructure
- Determinants of various infrastructures like water supply, road construction, dam construction, railway, electricity, port development, irrigation network ets

4. PRESENTATIONS: case studies
- Pumping stations and levees
- Waterways and canals
- Railway infrastructure
- Reservoirs and dams
- Solid waste management
- Education and Health infrastructure
- Infrastructure utilities planning

Recommended Literature:

1. Howes, R., & Robinson, H. (2006). Infrastructure for the built environment: global procurement strategies. Routledge.
2. Miller, J. D. (2007). Infrastructure 2007: A global perspective (No. ULI Catalog Number: I18).
3. Palve, S. N. (2013). Application of gis in infrastructure project management. International Journal of Structural and Civil Engineering Research, 2(4), 110-122.
4. Al-Hader, M., & Rodzi, A. (2009). The smart city infrastructure development & monitoring. Theoretical and Empirical Researches in Urban Management, 4(2 (11), 87-94.
5. Fletcher-Lartey, S. M., & Caprarelli, G. (2016). Application of GIS technology in public health: successes and challenges. Parasitology, 143(4), 401-415.
6. Trung, N. H., Tuu, N. T., Doan, T. C., Van Thinh, L., Tuan, D. D. A., & Nguyen, M. (2014). Application of GIS to support urban water management in adapting to a changing climate: A case study in Can Tho city, Vietnam. Report number: UCCRN Case Study, 14.
7. Rigaux, P., Scholl, M., & Voisard, A. (2001). Spatial databases: with application to GIS. Elsevier.
8. Masser, I., & Crompvoets, J. (2007). Building European spatial data infrastructures (Vol. 380). Redlands, CA: Esri Press.
9. Ghosh, J. K., & da Silva, I. (Eds.). (2019). Applications of Geomatics in Civil Engineering: Select Proceedings of ICGCE 2018 (Vol. 33). Springer.

APPLICATION OF GEOMATICS IN BIOGEOGRAPHY

Course code: GM-720 Credit Hours: 3

Objectives: To understand and apply Geomatics approaches in analyzing spatial variation of earth life in productivity, ecosystems and distinctiveness of biota specially focusing on latitudinal, depth and altitudinal diversity over the continents and oceans.

Course Outline: Introduction to Biogeography and Geomatics approaches: Biogeography in nineteenth and twentieth century, present day biogeography. Environmental setting: Earth's physical environments: Lithosphere, Hydrosphere, Atmosphere and the Biosphere, GIS and Geographic coordinate ecosystem, Geographic regions, mapping. The changing earth and Biogeographic processes and Geomatics approaches: Dispersal and mechanism of movement, Nature of barrier and dispersal routes, Geological Time Scale, Continental Drift Theory, Earth tectonic history, Climatic and biogeographic consequences of plate tectonic, Effect of Pleistocene on biogeographic dynamics, global warming and climatic change and Geomatics approaches.

Terrestrial biomes and application of GIS: Tropical rainforests biomes, Tropical dry forests biomes, Tropical savannas biomes, Desert biomes, temperate grasslands biomes, Mediterranean woodland and scrub land biomes, Temperate broad leaf deciduous forests area biomes, Boreal forest biomes and Tundra biomes and Geomatics approaches.

Hydro biomes and application of GIS: Fresh water biomes including rivers, streams, lakes and ponds. Marine Biomes including coastal, continental shelf and deep-sea biomes and Geomatics approaches.

Human-dominated biomes and application of GIS: The state of world population, Human use of earth, Earth capacity to support humans, spatial and temporal pattern of population, Population trends in the new century, urban and agroecosystems, conservation of environment in the urban and agro-ecosystems and Geomatics approaches.

Recommended Literature:

1. Groombridge, B. (1992), "Global Biodiversity: Status of the earth's living resources". Chapman and Hall, London.
2. IUCN and Government of Pakistan (GoP) (1992), "National conservation strategy". IUCN Pakistan and Government of Pakistan, Karachi.
3. Lomolino, M.V., Riddle, B. R. and Brown, J.H. (2006), "Biogeography". Sinauer Associates, Inc. publishers, Massachusetts.
4. Marsh, W.M. and Grossa, J. (2005), "Environmental Geography: Science, Land use and Earth systems" John Wiley & sons, Inc. Hoboken.
5. Mollett, J.A. (1984), "Planning for agricultural development". CROOM HELM, London.
6. Singh, S. (2006), "Environmental Geography". Prayag Pustak Bhawan, India.
7. Woodward, S.L. (2010), "Biomes of the earth: Terrestrial, aquatic and human dominated". Greenwood press, U.S.A.
8. Millington, A., Blumler, M., & Schickhoff, U. (Eds.). (2011). The SAGE handbook of biogeography. Sage.
9. Millington, A. C., Walsh, S. J., & Osborne, P. E. (Eds.). (2013). GIS and remote sensing applications in biogeography and ecology (Vol. 626). Springer Science & Business Media.

APPLICATION OF GIS IN DISASTER RESILIENCE AND RECOVERY

Course Code: GM 721 Credit Hours 3

Learning Outcomes: Upon successful completion of the course, the students shall be able to:

i. Understand about the concepts of disaster resilience and early recovery.
ii. Analyse various approaches adopted for disaster resilience and early recovery
iii. Evaluate different approaches and frameworks of disaster resilience and recovery

Course Contents

- Overview to course, disaster related concepts, Disaster Management Cycle and GIS Approaches
- Concept of Disaster Resilience and early Recovery
- Disaster Resilience and Application of GIS
    - o Disaster Resilience
    - o Components of Disaster Resilience
    - o Assessment of Disaster Resilience
- Approaches and Models of Disaster Resilience and Geomatics
    - o Quantitative Models of Disaster Resilience.
    - o Qualitative Models of Disaster Resilience.
- Application of GIS in Disasters and Mechanism of Early Recovery
- Application of GIS in Gender and Disaster Management
- Application of GIS in Mainstreaming Gender for Equitable Disaster Recovery
- Application of GIS in Disaster Recovery as an Opportunity for Social Transformation
- Application of GIS in Disaster Resilience and Disaster Recovery
- Application of GIS in Women, Disaster Resilience and Recovery

Recommended Literature:

1. Birmingham, L., and D. McNeill (2012) Strong in the Rain: Surviving Japan's Earthquake, Tsunami and Fukushima Nuclear Disaster, (New York: Palgrave Macmillan).
2. Diane Archer and Somsook Booyabancha (2011) Seeing disasters as opportunities: harnessing the energy of disaster survivors for change,' Environment and Urbanization, 23: 351-365.
3. Douglas Paton, and David Johnston (2006) Disaster Resilience: An Integrated Approach (Springfield, Illinois: Charles C. Thomas, Publisher).
4. Frank Thomalla,Tom Downing, Erika Spanger-Siegfried, Guoyi Han and Johan Rockstrom, (2006) 'Reducing hazard vulnerability: towards a common approach between disaster risk reduction and climate adaptation,' Disasters, 30(1): 39 – 48.
5. Kathryn Gow and Douglas Paton (eds) (2008) The Phoenix of Natural Disasters: Community Resilience (Springfield: Charles C Thomas Publishers).
6. Lisa Schipper and Mark Pelling (2006) 'Disaster risk, climate change and international development: scope for, and challenges to, integration,' Disasters, 30: (1): 19 – 38.
7. UNDP (2007) Human Development Report 2007/2008: Fighting Climate Change: Human Solidarity in a Divided World (New York: UNDP)
8. UNDP (2014) Human Development Report 2014: Sustaining Human Progress: Reducing Vulnerability and Building Resilience (New York: UNDP).

9. UNISDR (2007) Hyogo Framework for Action 2005 – 2015: Building the Resilience of Nations and Communities to Disasters (KOBE: UNISDR). 10. UNISDR (2015) Sendai Framework for Disaster Risk Reduction. 2015–2030 (SENDAI: UNISDR).
10. Duffield, M. (2013). Disaster-resilience in the network age access-denial and the rise of cyber-humanitarianism (No. 2013: 23). DIIS Working Paper.

GIS IN SUSTAINABLE TOURISM DEVELOPMENT

Course Code: GM 722 Credit Hours 3

Learning Outcomes: Sustainable tourism pursues the goal of economic development without damage on biological and ecological resources. GIS, being a tool for data mapping and analysis, serves as an efficient and effective tool for managers to trace the dynamics, predict different scenarios and make appropriate decisions in tourism planning and implementation.
Objectives: To train the students in the emerging field of tourism and recreation and factors affecting this industry.
After the course the student is expected to:

- Be familiar with the overall concept of sustainable tourism, as well as related concepts
- Understand the principles that underpin sustainable tourism
- Be aware of the complexity and conflicts between the different stakeholders as regard different land use
- Be able to identify impacts from tourism in an ecological perspective
- Understand the potentials of a GIS in developing a planning and management tool for sustainable tourism

Contents:

1. Introduction and scope of the Subject
2. Historical Development of tourism industry in the world.
3. Types of Natural Area Tourism Adventure tourism
    - Sport tourism
    - Cultural Tourism
    - Religious Tourism
    - Eco-tourism
4. Sustainable tourism; concepts, definitions and conflicts.
5. Planning, handling and management of tourism in sensitive landscapes.
6. Conflicts between tourism development, economic development and the environment at regional and local scale.
7. Tourism Decision Support System in a GIS; Digital maps and databases for planning.
8. Mapping of ecological sensitivity in natural areas.
9. Mapping and analyzing tourism environmental impact, such as hiking trail conditions
10. Prospects, potential and problem of tourism in Pakistan with special reference to security and law and order situation.

Recommended Literature:

1. Burton R. (1995). Travel Geography. Pitman Publishing London (2nd Edition)
2. Davidson, R. (1989). Tourism. Pitman Publishing London

3. Hall, C.M. & Page, S.G. (2001). The Geography of Tourism and Recreation. London, New York: Routledge. (Reprint)
4. Harssel, J.V (1994). Tourism and Exploration. Prentice Hall, New Jersey. (3rd edition)
5. Lea, J. (1988). Tourism and development in the third world. London, New York: Routledge.
6. Smith, S.L.J (1995). Tourism Analysis: A Handbook. Longman (2nd edition)
7. Williams S**.** (2009). Tourism Geography. A new synthesis. 2nd edition. London, New York: Routledge.
8. Lew, A. A., Hall, C. M., & Williams, A. M. (Eds.). (2008). *A companion to tourism*. John Wiley & Sons.
9. Ritchie, B. W., Burns, P. M., & Palmer, C. A. (Eds.). (2005). *Tourism research methods: integrating theory with practice*. Cabi.
10. Wanyonyi JW. Imwati A. Boitt M (2016) GIS in Analysis of potential Sites for Ecotourism– A Case Study of Kwale County. J Environ Sci Toxicol Food Tech (IOSR-JESTFT) 10(10):43-49.
11. Othman AG. Mohamed B. Bahauddin A. Som APM. Omar SI (2010) A Geographic Information System Based Approach for Mapping Tourist Accommodations in the East Coast states of Malaysia. World Appl Sci J 10:14-23.
12. Jamieson, W. (2006). Community destination management in developing economies. Psychology press.
13. Rahman, M. (2010). Application of GIS in Ecotourism Development: a case study in sundarbans, Bangladesh.
14. ***Journal and periodicals:***

Tourism Management
Annals of Tourism Research
Mountain Research and Development
Journal of Mountain Science
Journal of Eco-tourism and etc.

GIS FOR AGRICULTURE AND FOOD SECURITY

Course Code: GM 723 Credit Hours 3

Course Objectives:

By the end of this course the participants will be able to:

- A refresher on sustainable agriculture and food security
- Spatial data sources for agriculture and food security
- Analysis of spatial agriculture and food security data
- Creation of food security risk maps

Contents:

1. Introduction
   - Concepts and terminologies of GIS
   - Spatial information introduction
   - Agriculture and food security concepts introduction
   - Introducing GIS in agriculture and food security
2. Agriculture Spatial Data Collection
   - Data sources for disease information mapping
   - Mobile data collection using ODK.

- Data collection using handheld GPS devices
- Integrating GPS and ODK data into a GIS environment

3. Basics of Agriculture and Food Security
   - Raster Terrain Analysis-Slope
   - Network Analysis
   - Proximity Analysis
   - Normalized Difference Vegetation Index
   - Land Use Mapping
4. Spatial Analysis of Agriculture Related Data
   - Crop suitability Analysis
   - Creating yield maps
   - Vulnerability Assessment Mapping
5. Creation of Food Security Risk Maps

GIS application in Agriculture:

- GIS in yield monitoring and mapping
- Using GIS to report food security information
- Food security early warning systems and drought monitoring
- Characterizing soil spatial variability
- Use of GIS and remote sensing in food security analysis

Recommended Literature:

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