4-Year BS in Geomatics (GIS and Remote Sensing)
Semester Wise 4-Year Plan

Course code	Title	Cr. Hrs	Course code	Title	Cr. Hrs
Semester 1			**Semester 2**		
GM 311	Islamic Studies	2	GM 321	Pakistan Studies	2
GM 312	English-I	3	GM 322	English-II	3
GM 313	Introduction to Computing	3+1	GM 323	Geography-II: Atmosphere and Hydrosphere	3
GM 314	Geography-I: Lithosphere	3	GM 324	Fundamentals of GIS	3+1
GM 315	Map work and Projections	3	GM 325	Computer programming	3
GM 316	Basic Statistics	3	GM 326	Surveying and Leveling	3
		18			**18**
Semester 3			**Semester 4**		
GM 431	Remote Sensing and Photogrammetry	3	GM 441	Communication Skills and Report Writing	2+1
GM 432	Human Geography	3	GM 442	Spatial Analysis in Geomatics	3+1
GM 433	Cartographic Techniques	3+1	GM 443	Digital Image Processing	3
GM 434	Global Positioning Systems & Geodesy	3+1	GM 444	Geography of Pakistan	3
GM 435	Data Structure & Algorithms	3	GM 445	GIS Programming & Customization	3+1
GM 436	Object Oriented Programming	3	GM 446	Database Systems	3
		20			**19**
Semester 5			**Semester 6**		
GM 551	Active Remote Sensing & Space Laws	3	GM 561	Microwave & Hyper Spectral RS	3
GM 552	Spatial Decision Support Systems	2+1	GM 562	Multidisciplinary Application of Geomatics	3
GM 553	Project Management	3	GM 563	Research Methods	3
GM 554	Spatial Data Infrastructure & Standardization	3	GM 564	Geo-Statistics	3
GM 555	Spatial Data Modeling	2+2	GM 565	Mobile technology for data collection	2+2
		16			**17**
Semester 7			**Semester 8**		
GM 671	Environmental Geography	3	GM 681	Legal and Ethical Issues in Geomatics	3
GM 672	Research Project 6(3+3)*	3	GM 672	Research Project 6(3+3)*	3
-	Elective **	3	-	Elective **	3
-	Elective **	3	-	Elective **	3
		12			**12**

* Research Project is comprised of total 6 credit hours and is spread over two semesters i.e. 7 & 8.

** Elective course will be selected from the given list of courses

SEMESTER-1

Islamic Studies

Course Code: GM-311 **Credit Hours: 2**

Objectives: To impart an understanding of the fundamental principles and teachings of Islam through study of selected verses of the Quran and Prophetic Sayings. Important facets of the Prophet's life and salient, features of Islamic Civilization. To provide appreciation of other prominent religions, systems of ethics and cultures to prepare students to survive in international and multicultural work place.

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

Reference Material:

1. Shaukat Umari, *"Islam in the Light of a First Testament and Traditions"*
2. ZunaireHanif, *"What Everyone Knows About Islam"*
3. Hamidullah, *"Introduction to Islam"*

English-I

Course Code: GM-312 **Credit Hours: 3**

Objectives: Basic understanding of language skills including grammar and comprehension

Course Outline: Introduction, Need for English Skills, Listening Skills, Reading Skills, Language and Communication, Using Words Effectively, Parts of Speech, Non-Verbal Communication, Anonyms, Antonyms and Homonyms, Frequently Misused Words, Fundamental Writing Principles, Techniques and Style, Phrases, Sentences, Punctuation and Effective Use, Organizing the Thought Process, Brainstorming, Grouping, Sequencing, Outlining, Paragraphs, Compositions, Assignments and Short Paper, Improve Writing Techniques, Summary Development, Precise Development, Critical Review, The Research Paper, Letters, Vocabulary Development, Etymology, Abbreviations, Acronyms, Business Terminology, Increasing Word Power (Grammatical Rules) English Grammar, Punctuation Rules, Capitalization Rules, The Rules Of Grammar, Correct English Usage, Principles of Grammar

Reference Material:

1. Ketteley and Thompson (Latest Edition) *"English for Modern Business".*
2. Readers, D. (all periodicals) *"Better, Speak Better".* Readers Digest.

Introduction to Computing

Course Code: GM-313 **Credit Hours: 3+1**

Objectives: This course focuses on a breadth-first coverage of Information Technology discipline, introducing computing environments, general application software, basic computing hardware, operating systems, office working tools, Internet and computer usage concepts; Software engineering process, Social and ethical issues of computing.

Course Outline: Number Systems, Binary numbers, Boolean logic, History computer system, basic machine organization, Von Neumann Architecture, Algorithm definition and data structure design, and implementation, Programming paradigms and languages, Graphical programming,

Overview of Software Engineering, Operating system, Compiler, Computer networks and Internet, Computer graphics, AI, Social and legal issues.

Lab Outline: Computation of Number Systems; Binary, Octal, Hexa, Decimal number Systems, Implementation of Boolean functions, and basic machine organization e.g. motherboard, memory, I/O Cards, Input/Output Devices, Networking Devices, Concepts of Flow Charts, Environment of different Operating Systems; Linux, Unix, DOS, MS Windows, Introduction to Office Tools (MS Word, MS Excel, MS Access etc), Internet browsers and exposure to web based programming.

Reference Material:

1. Bailey and Lundgaard, (Latest Edition) "*Program Design with Pseudo-code",* Brooks/ Cole Publishing,
2. Lesley Anne Robertson, (2000) "*Simple Program Design: A step-by-step approach"*, Course Technology,
3. Larry Long and Nancy Long, (2002) "*Computers: Information Technology in Perspective*", 9th edition, Prentice Hall, ISBN: 0130929891
4. Schneider and Gersting, (2000) "*An Invitation to Computer Science"*, Brooks/Cole Thomson Learning.
5. Sherer, (Latest Edition) "*Computer Science: An overview of Computer Science"*.

Geography-I: Lithosphere

Course Code: GM-314 **Credit Hours: 3**

Objectives: This course attempts to impart the knowledge of physical geography including lithosphere, atmosphere and hydrosphere

Course Outline: Scope and status of Geography, The basic concept and theories in physical and human Geography including theory of continental drift, plate tectonics and peneplain concept, Factors of Landform Development, Weathering and Mass Wasting, Fluvial morphology, Desert Landforms, Glaciers and their topographic effects, Karstopography, Soil Development.

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 different types of landforms.

Field visits:

- Ground trothing, types of rocks, fluvial, glacial and desert landform identifing the various type of soil, identification of limestone topography and landforms.

Reference Material:

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. ISBN 0-03-098237-5.
3. Scott, R.C (1996) *"Introduction to physical geography*", West Publishing Co, New york. ISBN: 0-314-06260-2.
4. Miller, G.T (1996) *"Living in the Environment, Principles, connections and solutions"*, Ninth Edition, Wadsworth, ISBN0 534 23898 x.
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. Mcuveen (1992) "*Fundamentals of Weather and Climate*" Prentice Hall New Jersey.
8. Kendrew (1961): *"Climates of the continents*", Longman London/New York.

9. Thornbury, W.D. (Latest Edition) "*Principles of Geomorphology*" John Willy & Sons. New York.

Map Work and Projections

Course code: GM-315 **Credit Hours: 3**

Objectives: This course provides the 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.

Lab Outline: 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

Reference Material

1. Slocum, Robert McMaster, Fritz Kessler, Hugh Howard (2004) "*Thematic Cartography and Geographic Visualization*", 2nd Edition, Terry. ISBN, 0130351237.
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. Menno-Jan Kraak, FerjanOrmeling, *"Cartography, Visualization of Spatial Data"* (2002) 2nd Edition, ISBN 0130888907.
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.

Basic Statistics

Course code: GM-316 **Credit Hours: 3**

Course Outline: Introduction to Statistics, Descriptive Statistics, Statistics in decision making, Graphical representation of Data Stem-and Lead plot, Box-Cox plots, Histograms and Ogive, measures of central tendencies, dispersion for grouped and ungrouped Data, Moments of frequency distribution; examples with real life, use of Elementary statistical packages for explanatory Data analysis. Counting techniques, definition of probability with classical and relative frequency and subjective approaches, sample space, events, laws of probability. Conditional probability and Bayesian theorem with application to Random variable (Discrete and

continuous) Binomial, Poisson, Geometric, Negative Binomial Distributions; Exponential Gamma and Normal distributions.

Reference Material

1. Morris H. DeGroot, Mark J. Schervish, (2004) *"Probability and Statistics",* Amazon.
2. Murray R Spiegel, et al, (2004) *"Schaum's Outline of Probability and Statistics"*, Amazon.
3. Ronald E. Walpole, et al; (2004) *"Probability and Statistics for Engineers and Scientists*", Amazon.
4. Morris H. DeGroot, Mark J. Schervish, (2001) *"Probability and Statistics*", Amazon.
5. Walpole, (2000), "*Introduction to Statistics"*, Amazon.
6. Walpole, (2002) *"Probability for Statistics for Engineers*", Amazon.
7. Kreyszig, E. (2003), "*Advanced Engineering Mathematics"*, Amazon.

SEMESTER 2

Pakistan Studies

Course code: GM-321 **Credit Hours: 2**

Objectives: 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; Allama Iqbal: 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.

Reference Material:

1. Chaudary M. Ali (Latest Edition), "*The Emergence of Pakistan",* Amazon.
2. Khan, F K (2004) *"Geography of Pakistan"*, Oxford University Press, Karachi.
3. K.K. Aziz (Latest Edition) *"The Making of Pakistan",* Amazon.

English-II

Course code: GM-322 **Credit Hours: 3**

Course Outline:

Introduction to Oral Communication and its Application: Communicating at Work, Communication in Process, Communication in Organization, Oral Presentation and Oral Reports, Presentation: Face to Face Information Gathering, Communicating non verbally, Types of Non Verbal Communication, Developing good listening habits, Listening Barriers, Active listening Techniques, Oral Communication/Planning Business Communications, Short Talks and Presentation Types of Short Presentation/Modes of Delivering the Speech, Guidelines for presenting the speech, Oral Communication / Delivering Business Presentations, The Long Presentation & the Purpose of Presentations: Analyzing your audience, Parts of presentations, Verbal Visual supporting Materials, Conducting successful interviews, meetings and conferences, Types of Interviews, Leading Group and holding Successful conferences, Techniques for

participation in a meeting, Small group communication and Decision making, Use and values of small groups in effective organization, Basic problem solving procedure, Employment communication, Responsibilities of the interviewee, Responsibilities of the interviewer, Participation and leadership in small groups, Effective group participation, Effective group leadership, Old communication/methods of dictating techniques, Communication and telephone, Communicating effectively in international business, Non verbal communication in international business, Training needs in international business, Criteria for communicating effectively

Reference Material:

1. C.Glen Pearce, Rossfi Steven P. Golden, *"Business communication principles and applications"*
2. Cheryl Hamilton, Cordell Parker, Doyle D. Smith, "*Communication for result"*

Geography-II: Atmosphere and Hydrosphere

Course code: GM-323 **Credit Hours:** 3

Objectives: This course attempts to impart the knowledge of physical geography including atmosphere and hydrosphere

Course Outline: Scope and status of physical Geography, 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, cause and effects, Ocean circulation: Waves, currents and tides, their nature, causes and effects and impact on man and environment.

Lab Outline: 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:

- 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 and SUPARCO

Reference Material:

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. ISBN 0-03-098237-5.
3. Scott, R.C (1996) *"Introduction to Physical Geography*", West Publishing Co, New york. ISBN: 0-314-06260-2.
4. Miller, G.T (1996), "*Living in the Environment, Principles, Connections and Solutions*", Ninth Edition, Wadsworth, ISBN0 534 23898 x.
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. Mcuveen (1992) *"Fundamentals of Weather and Climate*" Prentice Hall New Jersey.
8. Kendrew (1961): "*Climates of the continents",* Longman London/New York.
9. Thornbury, W.D. (1969) *"Principles of Geomorphology",* John Willy & Sons. New York.

Fundamentals of GIS

Course code: GM-324 **Credit Hours: 3+1**

Learning Objectives The course aims at providing an understanding of GIS, its evolution, applications, spatial data models, structures and data handling with the help of GIS software to gain basic skills.

Course Outline:

- Introduction, Definitions, Key components.
- Functional Subsystem, Raster Data Model, Vector Data Model, Attribute Data Model.
- Data Techniques and procedures: Capturing, Transformation,
- Mathematical Approach, buffering, Spatial data Quality: Components of Data Quality, Micro Level Components, Macro Level Components , Accuracy
- Visualization of spatial data,
- Layers and Projections,
- Map Design: Symbols to Portray Points, Lines and Polygons.
- Graphic Variables, Visual Hierarchy, Data Classification Graphic Approach.
- Legal and ethical issues in GIS.

Lab Outline: Hardware/software, Raster/Vector/Attribute Data Display, Scanning, Digitization and Coordinate based point mapping, Raster / Vector Conversion, Data layer integration and display of different projections, Map layout, Data Classification and Thematic Mapping, Handling with Topological Errors and advance editing tools and project work.

Books Recommended:

Aronoff, S. (2004) Geographic Information Systems: A Management Perspective. WDL Publications, Ottawa, Fifth Edition.

Clarke, K. (2004) Getting started with Geographic Information System., Prentice Hall, New York, 2nd Edition.

Heywood, I., Cornelius, S. and Carver, S. (2003) An introduction to Geographic Information System. Addison Wesley Longman, New York, Second Edition.

Burrough, P. (2002) Principles of Geographic Information Systems for Land Resources Management. Oxford University Press, Oxford, Second Edition.

McDonald, R. and Burrough, P. (2001) Principles of Geographic Information Systems. Oxford University Press, Oxford, Second Edition

Foresman, T. (1997) The history of Geographic Information System. Prentice Hall, New York.

Computer Programming

Course code: GM-325 **Credit Hours: 3**

Objectives: The course is designed to familiarize students with the basic structured programming skills. It emphasizes upon problem analysis, algorithm designing, and program development and testing.

Course Outline: Fundamental programming constructs, translation of solution (algorithms) to programs, data types, control structures, functions, arrays, pointers, Graphical programming link lists, filing (sequential, Random) and testing of programs. Programme development with basic algorithms of searching & sorting, debugging of programming code.

Lab Outline: coding, executing and debugging of simple programs, Implementation of Constructs: if, then, switch, etc., Implementation of loops: for, while, Implementations of simple functions and overloading functions, Implementations of Arrays (1D, 2D), pointers (dynamic

memory allocation), link lists, sequential & random filing, data sorting, binary tree structures (bottom-up & top-down)

Reference Material:

1. Bailey and Lundgaard, (1988) "*Program Design with Pseudo-code"*, Brooks/Cole Publishing.
2. Lesley Anne Robertson, (2004) "*Simple Program Design: A step-by-step approach"*, 4/e, ISBN: 0-619-16046-2.

Surveying and Leveling

Course code: GM-326 **Credit Hours: 3**

Objectives: The purpose of this course is to present the material to familiarize the students with introductory surveying. Time will be spent on acquisition of theory and practical field skills reinforcement. Principles and applications are designed for use by civil engineers as well as those in civil technology.

Course Outline: Overview of surveying, objects and classifications 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.

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

Reference Material:

1. Anderson, J. M., Mikhail E. M., (1998), *"Surveying Theory and Practice*", 7th Ed., MCB/McGraw-Hill, US, ISBN 0-07-015914-9
2. Wolf P R., Ghilani C, 2005, Elementary Surveying : "*An Introduction to Geomatics"*,11th Edition, Prentice Hall, USA, ISBN 0131481894
3. Wirshing R., Wirshing R. J., (1985), "*Schaum's Outline of Introductory Surveying"*, McGraw-Hill, UK, ISBN 0070711240
4. McCormac J. C., McCourmac J. C., Anderson W., (1999), "*Surveying*", 4th Edition, Wiley, UK, ISBN 0471366579

SEMESTER-3

Remote Sensing and Photogrammetry

Course code: GM-431 **Credit Hours: 2+1**

Learning Objectives: This course introduces students to find out how pictures of the Earth's surface are recorded from aircraft and satellites and different ways these images can be analyzed.

Course Outline:

- Introduction to Aerial Photograph, Sensor Systems
- History of Remote Sensing and Photogrammetry
- Physical Basis (EM Spectrum, Energy Interaction,
- Spectral Reflectance Curves, Image Characteristics)

- Space and airborne, MSS, TM, ETM, HRV, LISS, IKONOS-2,
- Quick bird-2, AVHRR and others),
- Platforms (Types and Orbital Characteristics)
- Applications (agriculture, urban, natural resources etc.)

Lab Outline: Single band image interpretation, False color predictions, False color composite, Images Interpretation, Visual Interpretation of aerial photographs, Various sensors data comparison, display, Zooming, Identification of targets, Digital Image Processing (Over view of computer based image processing). Intro to ERDAS Imagine or ER Mapper, FIELD TRIP

Books Recommended:

Lillesand, T. M. and Kiefer, R. W. (2004). Remote Sensing and Image Interpretation. 5th edition. (John Wiley and Sons).

Mather, P M (2004) Computer Processing of Remotely Sensed Images. 3rd Ed. John Wiley and Sons.

Campbell, James B. (2002**)** Introduction to Remote Sensing. 3rdEd., The Guilford Press.

Gibson, P.J (2000) Introductory Remote Sensing: Principles and Concepts. Routledge,

Jensen, J. (2000) Remote Sensing of the Environment: An Earth Resources Perspective. Amazon Publishers.

Sabins, F.F (1996) Remote Sensing: Principles and Interpretation. 3rdEd., W H Freeman & Co.

Human Geography

Course code: GM-432 **Credit Hours: 3**

Objectives: This course attempts to impart knowledge about the relationship between man and environment including the distribution of population, human settlement, resources and related human activities.

Course Outline: Scope and Status of human Geography, Basic 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, Human Activities: Primary, secondary and Tertiary (agriculture, mining, forestry animal husbandry, poultry, light and heavy industries, transport and trade and tourism) and their impacts on environment, Natural resources, distribution and utilization: Renewable and non-renewable resources e.g., Air, land, water, fauna and flora fossil fuel metallic and nonmetallic minerals, Energy generation and consumption, Human Settlements: Evolution and housing types, Urban and Rural contrast, Land Use/land cover Pattern e.g. Commercial, Industrial and Residential, Open and Green Spaces, Transport, Theories of urban structure e.g., Concentric Zone Theory, Multiple Nuclei Theory, Sector Theory, Rural Settlements, Dispersed, Nucleated and Ribbon Settlements, City-Size, Distribution, Rank-Size Rule, Primate Cities.

Lab Outline: Survey and data collection from rural and urban settlements, regarding land use/ land cover, population and demographic and housing characteristics, services and utilities. Slums and Social Area Analysis, Analysis of Settlements from Topographic Sheets, Analysis of Settlements as Central Places, Analysis of Settlements as Population Foci, Analysis of Urban Areas, Cartographic Techniques to analyze and present field data

Field Visits: To identify the use of natural resources, to study land use and land cover, to study the urban structure, mining area, national parks, industrial areas and various rural and urban settlement.

Reference Material:

1. Rowntree, L. et .al (2004) "*Globalization and Diversity: Geography of a Changing World*" Prentice Hall, New York.
2. Neuwirth, R. (2004) "*Shadow Cities: A Billion Squatters, A New Urban World*" Routledge, London.
3. Harper, H.L. (2003) "*Environment and Society: Human Perspectives on Environmental Issues*" Prentice Hall; (3 Edition)
4. Knox, P.L. & S.A. Marston (2003) "*Places and Regions in Global Context: Human Geography*" Prentice Hall. (3rd Edition)
5. Becker, A. & Secker (2002) "*Human Geography: Culture, Society, and Space*" John Wiley and Sons. (7th Edition)
6. Blij, H.J.D. (2002) "*Human Geography: Culture, Society, and Space*" John Wiley and Sons (7th Edition)
7. Lewis, C.P. Mitchel-Fox & C. Dyer (2001) "*Village, Hamlet and Field: Changing Medieval Settlements in Central England*" Windgather Press.
8. Hagget, P. (1997): "*Geography: A Modern Synthesis*" Harper International, London.

Cartographic Techniques

Course code: GM-433 **Credit Hours: 3+1**

Objectives: Subject provides the 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 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, Choropleth Maps, Proportional Symbol Maps, Dot Maps, Isarithmic Maps, Cartograms, Flow Maps, Graduate Colour Maps, Map Compilation, Map Design, Cartography and Ethics, Map Production.

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

Reference Material

1. Slocum, Robert McMaster, Fritz Kessler, Hugh Howard (2004), *"Thematic Cartography and Geographic Visualization*", 2nd Ed., Terry. ISBN, 0130351237.
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. (Latest edition) "*Elements of Cartography*" 6th Ed., John Wiley & Sons, New York.
5. Menno-Jan Kraak, FerjanOrmeling, *"Cartography, Visualization of Spatial Data*" (2002) 2nd Ed., ISBN 0130888907.
6. AMAZON (1988), *"Cartography with ArcView GIS and Map Projection*", 5th Ed.
7. AMAZON (1988), "*Cartography: Thematic Map Design"*, 5th Ed.
8. AMAZON (1999) "*Multimedia Cartography*", 1st Ed.

Global Positioning Systems and Geodesy

Course code: GM-434 **Credit Hours: 2+1**

Learning Objectives: This course attempts to provide training on the fundamental aspects of GPS and Geodesy, various GPS measurements, their corresponding accuracies and identification of targets.

Course Outline:

- Introduction to GPS and Navigation System
- Components of GPS: Space Segment, Control Segment, User Segment
- GPS Data, Position and Time from GPS, Velocity
- GPS Errors, Sources of Errors
- GPS Satellite Signals, Pseudo-Range Navigation
- Differential GPS Techniques
- Tracking
- GPS Techniques and Project Costs

Lab Outline: GPS value reading, Easting Northing & elevation, Map Projections and Datum Settings, GPS based surveys, tracking, navigation and data processing, GPS Project.

Books Recommended:

Michael Kennedy (2002) The Global Positioning System and GIS: An Introduction. 2nd Edition, Taylor & Francis, New York.

Heywood, I., Cornelius, S. and Carver, S. (1999) An introduction to Geographic Information System. Addison Wesley Longman, New York, second edition. ISBN: 0 –81-7808 – 982 -3

Paul Zarchan (1996) Global Positioning System: Theory and Application. Volume I, American Institute of Aeronautics and Astronautics, Inc., Washington DC.

Aronoff, S**. (**1995) Geographic Information Systems: A Management Perspective. WDL Publications, Ottawa, Canada, Forth edition.

GPSCO (1992) Getting started with GPS Surveying. GPSCO Land Information Centre, NSW, Australia.

Data Structures and Algorithms

Course code: GM-435 **Credit Hours: 3**

Objectives: The course is designed to teach students structures and schemes, which allow them to write programs to efficiently manipulate, store, and retrieve data. Students are exposed to the concepts of time and space complexity and analysis of sorting and searching programs. Exposure to theory of NP-Completeness.

Course Outline: Introduction to data structures and Algorithms and their inter linkage; Efficient storage of ADTs (Abstract Data Types) and memory intensive problems. Advantages and disadvantages of different data structures using Arrays, Stacks, Queues, Priority Queues and Linked Lists.Recursion, sorting and searching algorithms, Hashing, Binary tree algorithim, Storage and retrieval performance of different techniques using various data structures.Introduction to theory of NP-Completeness and problem transformation.

Lab outline: Implementing ADTs using arrays, dynamic memory, Implementation of stacks, Queues & priority Queues, linked lists (single, double, circular), tree searching algorithms, hash

algorithms, performance of different data structure techniques, bubble sort and insertion sort for random and ordered data sets. Implementation and comparison of linear search and binary search.

Reference Material:

1. Frank M. Carrano, Paul Helman, Robert Veroff, "*Data Abstraction and Problem Solving with C++*", 2nd ed., Addison-Wesley, (1998).
2. Lafore, *Data Structures and Algorithms (SAMS teach yourself)*", Sams Publishing, 1999
3. Horowitz, Sahni, and Mehta "*Fundamentals of Data Structures in C++"*, Computer Science Press, (1995).
4. Standish, "*Data Structures in JAVA*", Addison Wesley, (2000).
5. Deitel and Deitel," *Data Structures in JAVA*", 4th ed., Pearson.
6. Aho, Hopcroft and Ullman, "*Design & Analysis of Algorithms"*.

Object Oriented Programming

Course code: GM-436 **Credit Hours: 3**

Objectives: The course aims to focus on object-oriented concepts, analysis and software development.

Course Outline: Evolution of OO, OO concepts and principles, problem solving in OO paradigm, OO program design process, classes, methods, objects and encapsulation; constructors and destructors, overloading operator and function overloading, derived classes, inheritance and polymorphism, I/O and file processing, exception handling

Lab coverage: Introduction Object Oriented Programming Environment, Implementation of OO simple programming: Classes, methods, objects instantation, abstract Class and Inheritance, class composition, class aggregation, Operator overloading, Implementation of I/O filing and implementation of polymorphism, Constructors, Distracters, abstract data types, file processing using OOPs.

Reference Material:

1. Budd,(Latest edition) "*Understanding Object Oriented Programming"*, Addison Wesley
2. Deitel and Deitel, (5th edition), "*Java: How to Program"*, Prentice Hall, ISBN 0131016210/0131202367 International Edition.
3. Deitel and Deitel, (4th edition), "*C++: How to Program"*, Pearson
4. Deitel and Deitel, (4th edition), "*Java: How to Program"*, Pearson
5. Bruce Eckel, (2nd Edition), "*Thinking in C++"*, Prentice Hall

SEMESTER-4

Communication Skills and Report Writing

Course code: GM-441 **Credit Hours: 3**

Objectives: To develop good Technical writing, language usage and reading skills. To appreciate the importance of communication and to develop 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.

Reference Material:

1. Vawdrey, Stoddard and Bell *"Business English"*.
2. Cheryl Hamilton, Cordell Parker, Doyle D. Smith "*Communication for result"*

Microwave and Hyper-spectral Remote Sensing

Course code: GM-442 **Credit Hours: 2+1**

Learning objectives: This course focuses on the basic concepts, data acquisition, working mechanism, spectral and spatial characteristics of microwave and hyper spectral data sets.

Course Outline:

- Introduction to Microwave Image Processing and Hyper-spectral Active Remote Sensing
- History and types of Microwave and Hyper-spectral Active Remote Sensing
- Sensor and Platform Types (RADAR, SAR, SLAR etc.)
- Advantages and Disadvantages of Active Remote sensing
- Working Mechanism, Spectral Characteristics of Microwave Images
- Like and Unlike Polarization, Key Concepts
- Image Geometry and interferometer
- Data Compression and Reconstruction, RADAR Image
- Pre-processing and Classification, Field Verification
- Data Fusion Techniques, Microwave Applications
- Channels and Spectral Libraries Sensors (AIS, AIVIS etc.)
- Application of Hyper-spectral data.

Lab Outline: Microwave Image Comparisons, Visual Interpretation of Radar Images, Radar Image pre-processing (Total Power Image, Ground Resolution, Rectification and Registration, Optical and data fusion case studies, Student Projects: Application Areas such as Mining, Environmental Monitoring, Vegetation Changes, Cropping Pattern, Salinity/Sodicity and Water Logging etc.

Books Recommended:

Campbell, James B. (2002) Introduction to Remote Sensing. 3rd Ed., The Guilford Press.

Henderson, F.M and Lewis, A.J (1998) Principles and Applications of Imaging Radar. Manual of Remote Sensing. 3rdEd. Vol. 2. John Wiley and Sons, New York..

Peebles, P.Z (1998) Radar Principles. Wiley Inter science, New York.

Elachi, C. (1988) Space-borne Radar Remote Sensing: Applications and Techniques. IEEE Press, New York.

Active Remote Sensing and Space Laws

Course code: GM-443 **Credit Hours: 3**

Objectives: This course is designed to introduce students to the use and applications of Active Remote Sensing and Space Laws.

Course Outline: Introduction to Active Remote Sensing and Space Laws, History, Introduction to Space Laws, International Space Agency, SUPARCO, Satellite Launching; Mechanism, Space Ethics Types of Active Remote Sensing. LiDAR, RADAR, SONAR, GPR, SRTM etc. Advantages and Disadvantages of Active Remote sensing, Sensor and Platform, Working Mechanism, Spectral Characteristics, Basic Concepts, Image Geometry, Data Compression and Reconstruction, Image Pre-processing and Classification, Field Verification, Data Fusion Techniques

Lab Outline: Introduction to Active Remote Sensed Image Processing, Image Comparisons, Visual Interpretation of Images, Image pre-processing, Student Projects: Application Areas

Reference Material:

1. Campbell, James B. (2002) *"Introduction to Remote Sensing"*, 3rd Ed., The Guilford Press ISBN # 0-7484-0663-8 (pbk).
2. Henderson, F.M and Lewis, A.J (Latest edition), "*Principles and Applications of Imaging Radar*".
3. John Wiley and Sons, "*Manual of Remote Sensing"*, 3rd Ed. Vol. 2.ISBN 0-471029406-3.
4. Peebles, P.Z (1998), "*Radar Principles"*, Wiley Inter science, New York.
5. Henderson, F.M. and Lewis, A. J (1998) *"Principles & Application Imaging Radar / Manual of Remote Sensing"* / 3rd Ed., Vol. 2, Published in Cooperation with the American Society for Photogrammetry and Remote Sensing, John Wiley & Sons, New York.
6. Elachi, C. (1988), *"Spaceborne Radar Remote Sensing: Applications and Techniques*", IEEE Press, New York.

Geography of Pakistan

Course code: GM-444 **Credit Hours: 3**

Objectives: The purpose of this course is to introduce students to the basic knowledge of our country such as history, physical environment, cultural environment, economic activities i.e. agriculture, industry, trade etc.

Course Outline: The making of Pakistan: The Genesis of Pakistan, The border of Pakistan and related problem, The Land: Physiography and physiographic regions, Climate and Climatic regions, Vegetation and Soils. The People and Economy: The People, Population, Agriculture and Irrigation, Power and Mineral resources, Industries, Urbanization, Communication and Trade. Pakistan and the World: Pakistan and her neighbours, Pakistan and the Muslims Countries, Pakistan and the Great Power, Pakistan and the third World Countries.

Reference Material:

1 Fazal Karim Khan (2004), "*A Geography of Pakistan",* Oxford University Press, Karachi.
2 Ahmad, K.S. (1990), "*Geography of Pakistan*".
3 Tayyab, "*A Political Geography of Pakistan*".
4 Spate, O.H.K., "*India and Pakistan*".
5 Burkey, J. Shahid, (1991), " *Pakistan the continuing search for Nationhood*", Western Press, Oxford, UK.
6 Ministry of Environment (1987), "*Environmental Profile of Pakistan and NWFP*", Ministry of Environment Islamabad.

GIS Programming and Customization

Course code: GM-445 **Credit Hours: 3+1**

Objectives: This course attempts to provide a foundation for customization of GIS using Model Builder and Python.

Course Outline: Introduction to course: Fundamentals of geo-processing; Exploring the toolbox; Running a tool from the ArcToolbox GUI

GIS customization: ArcGIS Model Builder; Modelling with tools, Opening and exploring Model Builder; Model parameters; Advanced geoprocessing and Model Builder concepts

Python language: PythonWin; Python fundamentals; Working with variables; Objects and object-oriented programming; Classes; Inheritance; Python syntax; Lists; Loops; Decision structures; Strings; Python script tools; Troubleshooting; Batch processing

Python functions and modules: Arcpy module; Reading attribute data; Cursors; Working with raster data; Reading and parsing text files; Writing geometries; Working with map documents

Lab outline: Students are required to practice the knowledge of customization of tools, model making and scripting using Arcpy/ArcGIS.

Reference Material:

1. Chun, W. J. (2012). *Core Python Programming (3rd ed.)*: Prentice Hall, London
2. Lutz, M. (2013). *Learning Python (5th ed.)*: O'Reilly Media, Inc. Sebastopol, CA. USA
3. Pimpler, E. (2013). *Programming ArcGIS 10.1 with Python Cookbook*: Packt Publishing Ltd. Birmingham, UK
4. Swaroop C. H. (2016). A Byte of Python: Free book available at http://swaroopch.com/notes/python
5. Zandbergen, P. A. (2013). *Python scripting for ArcGIS*: Esri press, California, USA

Database Systems

Course code: GM-446 **Credit Hours: 3**

Objectives: The course aims to introduce basic database concepts, different data models, data storage and retrieval techniques and database design techniques. The course primarily focuses on relational data model and DBMS concepts.

Course Outline: Basic database concepts; Entity Relationship modeling, Relational data model and algebra, Structured Query language; RDBMS; Database design, functional dependencies and normal forms; Transaction processing and optimization concepts; concurrency control and recovery techniques; Database recovery techniques; Database security and authorization. Small Group Project implementing a database.

Lab outline: Structured Query language commands, PL/SQL Commands, Creating & populating tables, Design of simple database: Conceptual, logical and physical level, Database normalization process techniques, Query optimization (Relational Algebra), Indexing concepts, Performance of concurrency protocols, Partial & full recovery techniques, Concepts of database securities, Development of a GUI interface (optional). Design and implementation of a simple MIS system

Reference Material:

1. Date, C.J. (2004), "*Database Systems",* Addison Wesley Pub. Co. ISBN -0201385902
2. Connolly R. and P.Begg (2003), "*Database Systems: A Practical Approach to Design, Implementation and Management",* Addison-Wesley Pub. Co ISBN – 0321210255

3. Elmasri, R. and Navathe, S.B (2004) "*Fundamentals of Database Systems"* Addison-Wesley Pub. Co ISBN – 0-201760355
4. Rigaux, P. Scholl, M. and Voisard, A.(2001) "*Spatial Databases: With Application to GIS*" Morgan Kaufmann; 2nd edition ISBN -01017386802

SEMESTER-5

Digital Image Processing

Course code: GM-551 **Credit Hours: 3+1**

Objectives: This course builds on the introductory Remote Sensing unit and provides practical applications of digital image processing of remotely sensed data for analysis of Earth resources.

Course Outline:

- Introduction to Digital Image Processing
- Data Sources and Procurement
- Data Formats (BSQ, BIL, BIP, etc.) Image Sub-setting& Enhancement
- Image Cleaning, Atmosphere Path Correction
- Image Mosiacing and Color Balancing, Image Rectification, Registration and Re-sampling
- Band Ratios, Vegetation Indices, Image Filtering
- Principal Component Analysis, Classification Schemes
- Types, Algorithms, Field data collection,
- Qualitative and quantitative techniques, sampling techniques, Error matrices

Lab. Outline: Image Management (Import/Export & Display), Enhancement Techniques, Spectral and spatial digitizing (image masking). Supervised, Unsupervised and Hybrid classification, Error Matrix Generation, Classification validation, Ground-Verification (Field Verification)

Note: Project (from third week students will be advised to commence their project work in a teamwork environment. Project work will be based on real life data sets obtained from resource monitoring agencies such as SUPARCO, SOP).

Books Recommended:

Mather, P (1999, 2004) Computer Processing of Remotely Sensed Images. 3rdEd. J Wiley.

Jensen, J. R. (2002) Digital Image Processing: A Remote Sensing Perspective. Prentice Hall, New York.

Gibson, P.J and Power, C.H (2000) Introductory Remote Sensing: Digital Image Processing and Applications. Routledge, ISBN 0-415- 18962-4

Sonka, M.Hlavac, V and Boyle, R (1999) Image Processing, Analysis and Machine Vision. 2ndEd., International Thompson Publishing (ITP) Company,

Schowengerdt, R A (1997) Remote Sensing, Models and Methods for Image Processing. Academic Press.

Spatial Decision Support Systems

Course code: GM-552 **Cr. Hrs: 2+1**

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

- Introduction: Definitions of SDSS.
  - Spatial Decision Making. Types of Spatial Decisions. Spatial Decision-Making Problems. Spatial Decision-Making Process. Need for Decision Support Systems. SDSS Characteristics. Examples of SDSS
- Evolution and Trends in SDSS:
  - Origins of SDSS. Core Drivers for the Development of Spatial Decision Support Technology Introduction Phase (1976–1989). Integration Phase (1990–2000). Implementation Phase (2000s). DSS to SDSS. GIS-Based Evolution. GIS to SDSS. SDSS Progression
- Components of SDSS I:
  - Geographic Information Systems. Components of Traditional DSS and GIS. Components of SDSS. Overview of Geographical Information Systems
- Components of SDSS II:
  - Model Management Component. Modeling Techniques in SDSS. Generic Models. Dialog Management Component. Stakeholders Component. Knowledge Management Component. SDSS Software Components
- Building SDSS:
  - Building Desktop SDSS. Building Web-Based SDSS
- SDSS Applications
- SDSS Challenges and Future Directions

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

Books Recommended:

Ramanathan Sugumaran and John DeG. (2011). Spatial Decision Support Systems: Principles and Practices, Taylor and Francis Group LLC

A . E. Turban and Aronson J. (1998), Decision Support Systems and Intelligent Systems, 5th edition, Prentice Hall.

B .Sauter, V. (1997) Decision Support Systems. John Wiley & sons, Inc.

Densham,P. J. (1991). Spatial Decision Support Systems. In D. J. Maguire, M. F. Goodchild, & D. W. Rhind (Eds.), Geographical Information Systems, Volume 1 : Principles (Vol. 1, pp. 403-412): Longman.

Keenan,P. B. (2003) "Spatial Decision Support Systems," in M. Mora, G. Forgionne, and J. N. D. Gupta (Eds.) Decision Making Support Systems: Achievements and challenges for the New Decade: Idea Group, pp. 28-39.

Karen K. K. (2008). Encyclopedia of Geographic Information System. Sage Publications, London.

Research Methods

Course code: GM-553 **Credit Hours: 3**

Course Contents: 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 Data Processing flow: Editing, Coding, Handling Blank Responses, Coding, Categorization, Converting, Weighting, Storing etc., Alternative processing flows, University data analysis, Measurement of central tendency, Measurement of dispersion, Hypothesis Testing, Bavaria data analysis, Linear Correlation, Simple Regression, The Chi-Square Test, The Cross-Tabular Tables, Elaboration of relationships, Multivariate data analysis: Interdependence Methods, Factor analysis, Cluster analysis, multidimensional analysis, Multivariate data analysis: Dependence methods, Multiple Regressions, Analysis of Variance & Covariance, Discriminate analysis. Research Project Proposal: Rationale for the study defining the problem, Research Objectives, Information needs, Research design, Data collection procedure, Data processing & analysis, Research Team and its profile, Budget, Time Table

Reference Material:

1. Ranjit Kumar, "*Research Methodology*", Latest edition, Sage Publications.
2. IngemanArbonor And BjoranBerke, "*Methodology for Creating Business Knowledge*", Sage Publications.
3. Dam Remenyl (1999), "*Doing Research in Business and Management*", Sage Publications.
4. David H. Folz (1999), "*Survey Research for Public Administration*", Sage Publications.
5. C. William Emory, "*Business Research Methods*", (Latest edition), IRWIN.

Spatial Data Infrastructure and Standardization

Course code: GM-554 **Credit Hours: 3**

Objectives: This course attempts to provide an understanding to the data structures, processes and its standards which are involved in data sharing. Subject includes the applications and architecture of Spatial Data Infrastructure.

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 Modeling, Data Modeling 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.

Lab Outline: 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.

Reference Material:

1. Robert, C. H. (2005), "*SDI : A View from Europe*" Oxford University Press, Oxford, ISBN: 089875982X.
2. Groot, R. (2001), "*Geospatial Data Infrastructure: Concepts, Cases, and Good Practice (Spatial Information Systems (Cloth)"*, Oxford University Press.
3. Beth E. Lachman (2001), "*Lessons for the Global Spatial Data Infrastructure: International Case Study Analysis*", RAND Corporation.
4. Mapping Science Committee (1993), "*Toward a Coordinated Spatial Data Infrastructure for the Nation*". National Academy Press.

Spatial Data Modeling

Course code: GM-555 **Credit Hours: 3**

Objectives: This course attempts to provide an introduction to GIS data models and data structures. The subject continues with a systematic overview of spatial data models (e.g. raster and vector) and the structures used to implement these, together with methods of spatial feature addressing, geometry of objects, topology, object hierarchies and aggregations, the modeling of fuzzy objects and the uncertainty aspects of spatial data.

Course Outline: Introduction to Fields, Objects, Geometry**,** Objects represented in raster, Vector Structure, Vector data representing the geometry of geographical objects, Networks and graphs, Properties of Graphs, graph areas and error checking procedures, Terrain object classed and generalization hierarchies aggregation hierarchies, object association, Fuzzy set theory, fuzzy boundaries, Uncertainties of Spatial Objects.

Lab Outline: Preparation of Symbolic Charts for representation of Earth Features, Assignment on Geometry of spatial objects, Utility Network Analysis, Spatial data generalization and aggregation

Reference Material:

1. Michael, N. D.(2003) "*Fundamentals of Geographic Information Systems*" 3rd Ed., John Wiley & sons.
2. Heywood, I., Cornelius, S. and Carver, S. (1999) "*An introduction to Geographic Information System*", 2nd ed., Addison Wesley Longman, New York.
3. DeMers, M. (1996), "*Fundamentals of Geographic Information Systems*", John Wiley & Sons, New York.
4. Burrough, P.*,* (1986), "*Principles of Geographic Information Systems for Land Resources Management*", Oxford University Press, Oxford.

SEMESTER-6

Spatial Analysis in Geomatics

Course code: GM-561 **Credit Hours: 3+1**

Objective: This course provides a detailed examination of the common spatial analytical tools used in a Geographical Information Systems environment. Students are given 'hands-on' experience with data extraction techniques, data reduction techniques, data modeling (statistical and inferential) and data evaluation methodologies. The students are also introduced to image processing in a spatial context. Real world applications provide the mechanism for gaining experience with the analytical techniques detailed above. Spatial analyses are undertaken using mainly ESRI's ArcGIS

Course Outline: Understanding the concept (vector, raster and statistical analysis), Thematic Mapping, Distance Measurements, Vector Data Query and Object Selection, Buffering, Interpolation, Density Mapping and Map Overlay, Network analysis, Topographic Analysis 3D mapping

Reference Material

1. David O' Sullivan and David J. Unwin (2003), "*Geographic Information Analysis*", John Wiley & Sons, Inc., Canada. ISBN: 0- 471-2117-1
2. Chang, Krang-tsung (2002), "*Introduction to Geographic Information Systems*" McGraw Hill. ISBN: 0-07-049552-1
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.1-57504-101-4
4. John Stillwell & Graham Clarke (2004), "*Applied GIS and Spatial Analysis*", John Wiley & Sons, UK. ISBN: 1-57504-101-4
5. Peter M. Atkinson and Nicholas J. Tate (1999), "*Advances in Remote Sensing and GIS Analysis*" John Wiley & Sons, UK. ISBN:0-471-985070-5
6. Heywood, I., Cornelius, S. and Carver, S.(1999), "*An introduction to Geographic Information System*", Addison Wesley Longman, New York, 2nd ed., ISBN: 81-7808-982-3
7. Paul, L., Michael, G., David, M. & David, R.(1999), "*Geographic Information Systems: Principles, Techniques, Applications and Management*", John Wiley & Sons, ISBN: 0-471-73545-0
8. Peter A. Burrough& Rachael A. McDonnell (2000), "*Principles of Geographical Information Systems*"**,** Oxford University Press Stewart Fotheringham
9. Robert Haining (2003), "*Spatial Data Analysis : Theory and Practice",* Cambridge University Press ISBN: 0521774373
10. Michael Batty & Paul A. (2003), "*Longley Advanced Spatial Analysis*", The CASA Book of GIS Publisher: ESRI Press ISBN: 1589480732

Multidisciplinary Applications of Geomatics

Course code: GM-562 **Credit Hours: 3**

Objectives: This course covers important fields of application of Geomatics. The course covers various topics from the multidisciplinary special area.

Course Outline: Introduction to the course, identification of important areas of applications, natural hazards, disasters, water related issues, environmental issues, administrative and managerial issues, land cover/ land uses, developmental projects, watershed management, urban planning, rural areas planning etc.

Reference Material:

1. Lillesand, T. M. and Kiefer, R. W. (2004), "*Remote Sensing and Image Interpretation*", 5th ed., (John Wiley and Sons), ISBN 0-471-15227-7
2. Mather, P M (2004), "*Computer Processing of Remotely Sensed Images*", 3rd Ed., (John Wiley and Sons), ISBN 0-470-84919-3
3. Campbell, James B. (2002), *"Introduction to Remote Sensing"*, 3rd Ed., The Guilford Press, ISBN # 0-7484-0663-8 (pbk).
4. Gibson, P.J (2000), "*Introductory Remote Sensing: Principles and Concepts*", Routledge, ISBN 0-415-19646-9
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, ISBN # 0-7167-2442-1

Journals / Periodicals:

1. International Journal of Remote Sensing
2. Remote Sensing of Environment Journal
3. Photogrammetric Engineering & Remote Sensing Journal
4. Geo Carto International Journal
5. Asian Pacific Remote Sensing Journal
6. Canadian Journal of Remote Sensing

Project Management

Course code: GM-563 **Credit Hours: 3**

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

Course Outline: Overview, project management**,** project organization, projection selection models and techniques, Cost Benefit analysis, Project planning, project scheduling, project monitoring, reporting and controlling, and project termination.

Reference Material:

1. Merideth, J.R., Sammuel, J. Manbel. (1989), "*Project Management*", New York, John Wiley. ISBN: 0471-85319-4
2. Choudhry, S. Taha, (2000), "*Project Management*", India, McGraw Hill.ISBN: 0-13-032374-8
3. LittleI.M.D.,Mirrlees, J.M. (1982), "*Project Appraisal and Planning for Developing Countries*", India, Oxford and IBH. ISBN: 0-435-84501-2

Geo-Statistics

Course code: GM-564 **Credit Hours: 3**

Learning Objectives: This course teaches various basic statistical and geostatistical methods through lab exercises and a final project.

Learning Outcomes: This course produces the skills of utilization of these geostatistical tools and method in analyzing the geodata.

Course Outline:

Introduction: Statistics & Geostatistics; overview of different types of data – spatial & non-spatial; Feature and geographic spaces; Univariate description: Frequency Tables and Histograms, Cumulative Frequency Tables and Histograms, Normal and lognormal Probability Plots, Summary Statistics, Measures of Spread, Measures of Shape; Bivariate description: Comparing Two Distributions, Scatterplots, Correlation, Linear Regression

Exploring and visualizing spatial data: Spatial description; Data Postings, Contour Maps, Symbol Maps; Indicator Maps; Spatial Continuity; h-Scatterplots; Correlation Functions; Covariance Functions; Variograms; Cross h-Scatterplots

Modeling the Sample Variogram: Basic Permissible Models; Circular, Spherical, Exponential, Gaussian, Linear; Fitting models; Omnidirectional variogram modelling; Modelling the Anisotropy Axes; Choosing the Directional Tolerance; Relative Variograms; Cross-Variograms

Interpolation: Deterministic vs Geostatistical interpolation: IDW; Kriging: types of Kriging; Simple Kriging, Ordinary Kriging; Co-kriging; Cross Validation

Lab: Practical exercises with Geostatistical Analyst of ArcGIS.

Reference Material:

1. Choudhry, S. M. & Kamal, S. (2009). *Introduction to Statistical Theory*: Markazi Kutub Khana, Lahore
2. Delfiner, P., and Chiles, J-Paul. (2012). *Geostatistics: Modeling Spatial Uncertainty (2nd ed.):* John Wiley & Sons Ltd., Hoboken, United States.
3. Hengl, T. (2009). *A Practical Guide to Geostatistical Mapping*: University of Amsterdam, Luxembourg (ISBN: 978-92-79-06904-8).
4. Isaaks, E. H. and Srivatava, R. M. (1989). *Applied Geostatistics*: Oxford University Press, Inc., New York.
5. McKillup, S. and Dyar, M. D. (2010). *Geostatistics Explained: An Introductory Guide for Earth Scientists:* Cambridge University Press, Cambridge, UK
6. Webster, R. and Oliver, M.A. (2007). *Geostatistics for Environmental Scientists (2nd ed.):* John Wiley & Sons Ltd., England.

Mobile technology for data collection

Course code: GM-565 **Credit Hours:(2+2) 4**

Learning Objectives: The subjective of the course is to make students familiar with the use of different mobile technologies for the real time data collection from field and its analysis.

Course Outline:

- Introduction to mobile technology
- History of Mobil Technology for Data Collection
- Scope & status of Mobil Tech in modern era
- Applications of GPS enabled Mobil tech in different sectors

- Type of mobile phone used for data collection GPRS and GPS enabled.
- Questionnaire Designing for Mobile Applications
- ODK Tools registration & preparation and configuration for Survey
- Form Uploading and Retrieving
- Field orientation and practice for various types of data including x-y coordinates and its retrieval,
- Visualization and analysis through ODK and relevant database systems and software's

Lab. Outline: Tools registration, preparation and designing of questionnaires in xml, field survey, categories, their uploading and implementation.
Field Outline Field orientation and practice for various types of data including x-y-z coordinates and its retrieval, visualization and analysis through ODK (open Data toolkit).
Books Recommended:

Fogg B.J. (2003) Persuasive Technology: Using Computers to Change What We Think and Do. (Interactive Technologies). Kaufmann Morgan Publishers San Francisco, USA

Gary, W. (2010) The Mobile Learning Edge: Tools and Technologies for Developing Your Teams. McGraw-Hill.

Kevin S. and Klaas, W. (2011) Building the mobile networking technology. Cisco Systems Indianapolis, USA.

Muehlenhaus I. (2014) Web Cartography: Map Design for Interactive and Mobile Devices. CRC Publisher, London.

Quinn C N. (2011) The Mobile Academy: M-Learning for Higher Education. John Wiely and Sons.

Trimble 2009: Mapping and GIS customer stories. URL source: http://www.trimble.com/mgis/customer_stories.aspx

Tsou, M.-H. (2004). Integrated mobile GIS and wireless internet map servers for environmental monitoring and management. Cartography and Geographic Information Science 31(3), 153-165.

Wankel, LA and Blessinger P. (Eds.) (2013) Increasing Student Engagement and Retention using Mobile Applications: Smartphones, Skype and Texting Technologies (Cutting-Edge Technologies in Higher Education). Emerald publishing services UK.

URL Sources:

http//mobile phones for data collection mobile active .org

http://www.theclearinitiative.org/mobile-based-tech.pdf

SEMESTER-7

Environmental Geography

Course code: GM-671 **Credit Hours: 3**

Objectives: This course is designed to enhance the knowledge of the students about the environment, its relevance with mankind and current problems are also included to highlight human impacts.
Course Outline: Meaning, scope, nature, importance and basic concepts. Resources and its management: human resources, water as a resource, soil as a resource, forest resources, land and agricultural resources, minerals & rocks resources, energy resources. Environmental processes: types, Causes, Effects, Consequences and remedies of Fluvial Processes, Glacial and Peri-glacial Processes, Mass Movements, Wind Action, Marine Processes, Endogenetic Processes, Desertification. Eco-System: Terrestrial, Aquatic, biosphere and Atmospheric Ecosystem.

Emerging Environmental problems: Land Degradation, Atmospheric Pollution, Water Pollution. Environmental appraisal, legislations, institutions and management.

Reference Material:

1. Alexander D. (1993), "*Natural Disaster"*. UCL Press.
2. Bell, M. & Walker, M.J.C. (1992), "*Late Quaternary Environmental Change: Physical and Human Perspectives*". Longman Group. U.K.
3. Brimicombe, A. (2003), "*GIS, Environmental Modeling and Engineering*", Taylor and Francis. London.
4. Cooke, R.U. et al. (1982), "*Urban Geomorphology in Dry Land*", Oxford University Press, London.
5. David, D. (1983), *"Man-Environmental Process*", George Allen &Unwin, London.
6. Getis, et al. (2004), "*Introduction to Geography*", McGraw Hill, Boston.
7. GoP (1992), "*Pakistan National Conservation Strategy*", Environment and Urban Affairs Division Islamabad.
8. Jack, G. (1990), "*Environmental Geography*", Longman Ltd. UK.
9. Jonson, B.L.C. (1969), "*South Asia: selective studies of the essential geography of India*, *Pakistan and Ceylon*", Heinemann Educational.
10. Khan M.Z. &Agarwal (2004), "*Environmental Geography*", Printice Hall, New Delhi.
11. Khan, F.K. (1991), "*A Geography of Pakistan*", Oxford University Press, Karachi.
12. King, C.A.M. (1978), "*Techniques in Geomorphology"*, Edward Arnold, London.
13. Knapp, B. (1989), "*Challenge of the Natural Environment*", Longman Group, New York.
14. Marsh, W.M. &Grosha, J. (2005), "*Environmental Geography: Science, land use and earth system*", John Wiley and sons. Hoboken.
15. Montgomery C.W. (2002), "*Environmental Geology*", McGraw-Hill, London.
16. Mottershead&S.J.Harrison (1984): Environmental System, An Introductory Text. Allen &Unwin, London.
17. Watt, K.E.F. (1992), "*Understanding the Environment*", Allyn and Bacon. London.

Research Project

Course code: GM-672 **Credit Hours: 6(3+3)**

Course Outline: The research project is a major component of the programme in which the student will demonstrate an ability to independently integrate knowledge, skills and competencies acquired from all earlier courses, together with an opportunity to consolidate and develop additional skills in the use and application of research methodologies. This independent study will be defined in consultation with the course co-ordinator and will be based on:

- A specific research topic brought from the Remote Sensing & GIS industry. In this case, the topic will be discussed and finalized by mutual consultation of the corresponding industry, student and the 4-year BS Geomatics (GIS & RS) course coordinator of the University.
- A research project proposed by research supervisor or associate researchers within or outside the host university.
- A development from a guided project pursued in RS and GIS, Applied Remote Sensing or an idea developed by the student during the earlier taught parts of the course. In all cases there will be a close liaison prior to, and during the project between the student, the course contributors and relevant industry organizations.

Note: Research project is of 6 credit hour spread over two semesters i.e. semester 7 and 8.

List of Elective courses

Code	Title	Credit Hours
GM-673	Advanced Geographic Information System	3
GM-674	Integrated Land and Water Information System	3
GM-675	Map Information System and Function	3
GM-676	Advanced Photogrammetry	3
GM-677	Computer Aided Drafting	3
GM-678	Economic Geography	3
GM-682	Application of Geomatics in Project Planning and Management	3
GM-683	Advanced Geodatabase and Programming	3
GM-684	Biogeography	3
GM-685	Calculus and Analytic Geometry	3
GM-686	Discrete Mathematics and Linear Algebra	3
GM-687	Statistics and Probability	3
GM-688	Land Information System	3
GM-689	Advanced Remote Sensing Applications	3

Advanced Geographic Information System

Course code: GM-673 **Credit Hours: 3**

Objective: This course will familiarize students with adv
anced topics of GIS such as spatial database accuracy assessment, 2D and 3D spatial modeling, analysis of discrete and continuous entities in space.

Course Outline: Introduction to course, Co-ordinate Systems and Map Projection, Cartographic Errors and Rectification Procedures, Editing Cartographic Data Visualization of Geospatial Data, 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, Map Overlay Analysis, Multivariate Data, Multidimensional Space and Spatialization, GIS Modeling and Related Issues. Geostatistical Analysis,

Reference Material:

1. Clarke, K. (2004), "*Getting started with Geographic Information System*", Prentice Hall , New York, 2nd Ed., ISBN -1879102897
2. Foresman, T. (Latest version), "*The history of Geographic Information System*", Prentice Hall, New York. ISBN – 0138621454.
3. Stewart Fotheringham, Chris Brunsdon, Martin E Charlton (2000), *Quantitative Geography: Perspectives on Spatial Data Analysis*" SAGE Publications ISBN: 0761959483.
4. Jacek Malczewski (1999), "*GIS and Multi-criteria Decision Analysis",* John Wiley & Sons, Inc. ISBN: 0471329444.
5. John Stillwell (2004), "*Applied GIS and Spatial Analysis*", John Wiley & Sons, Ltd. England ISBN: 0470844094.
6. Aronoff, S. (2004), "*Geographic Information Systems: A Management Perspective*", WDL Publications, Ottawa, Fifth Edition. ISBN - 0912804008
7. Heywood, I., Cornelius, S. and Carver, S. (2003), "*An introduction to Geographic Information System*", Addison Wesley Longman, New York, Second Edition. ISBN - 0130611980
8. Burrough, P.(2002), "*Principles of Geographic Information Systems for Land Resources Management*", Oxford University Press, Oxford, Second Edition. ISBN - 0198233655
9. McDonald, R. and Burrough, P. (2001), "*Principles of Geographic Information Systems*", Oxford University Press, Oxford, Second Edition ISBN - 0198233855
10. Martien Molenaar (1998), *An Introduction to the Theory of Spatial Object Modelling for GIS*", Taylor & Francis, Inc. ISBN: 074840774X.

Integrated Land and Water Information System

Course code: GM-674 **Credit Hours: 3**

Learning objective: 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.

CONTENTS: Introduction to course, Displaying geographic data, Structure of spatial data in ILWIS, Displaying maps and Layer management, about 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.

References

1. ITC (2008) "*ILWIS Application Guide*", International Institute for Aerospace Survey and Sciences, Netherland.
2. ITC (2001) "*ILWIS Academic User's Guide*". International Institute for Aerospace Survey and Sciences, Netherland.
3. Aronoff, S. (2005) "*Remote Sensing for GIS Managers*". ESRI Press, New York.
4. Maginr, D. J. (1991) "*Geographic Information System".* Longman, London.

Map Information System and Function

Course code: GM-675 **Credit Hours: 3**

Learning objective: To train students in Map Information system in GIS environment, its uses, integrating the spatial data as well as analysis and application.

Course Outline: Introduction to Map Information system, main concept, data input, manipulation of data, spatial data input, data output, projection and coordinate system, conversion tool and its uses, spatial objects, Data base development and management, attribute data handling, spatial data analysis, layout of spatial data, data base query, saving of layout in raster format, display of spatial and attribute data, and presentation of result in the form of maps, diagrams and tables.

Reference Material

1. MapInfo (2009), "*Application User Guide Book (version 8*)".
2. Maginr, D. J. (1991) "*Geographic Information System".* Longman, London.
3. MapInfo (1998), "*User's Guide Book (version 5.2)*"
4. MapInfo (1999), *"Application User's Guide Book (version 5.12)".*

Advanced Photogrammetry

Course code: GM-676 **Credit Hours: 3**

Learning Objectives: This course attempts to provide knowledge about the key aspects and application of modern photogrammetry such as aerial photographs, digital images, pixels, DN value, techniques of measuring 2 D and 3 D objects, stereo photogrammetry and its applications.

Course Outline:

- Introduction to course, Analog and digital photogrammetry
- Types of Aerial Photographs and mosaics
- Photogrammetric cameras
- Review of data acquisition and single photograph properties
- Spatial measurement and scale calculation,
- Aerial Photograph Interpretation,
- Stereoscopic Analysis DEM generation,
- Orthophotography/ Orthoimage, applications.

Lab Outline: Comparison of formats**,** Sensor, films and filters, Data acquisition methods, Area and scale measurement, Visual interpretation of aerial photographs, vertical airphotos, problems with aerial photograph and rectification of a single aerial photograph, case studies.

Books Recommended:

Sabins S.F (2000) Remote Sensing: Principles and Interpretation. Third Edition. Freeman and Company, New York.

Lo, C.P (latest version) Applied Remote Sensing. Longman, London.

Philipson, W.R (1997) Manual of Photographic Interpretation. 2nd ed., American Society for Photogrammetry and Remote Sensing.

Colwell, R.N (ed.), (Latest version) Manual of Remote Sensing. 2nd Ed., 2 vol., American Society of Photogrammetr

Computer Aided Drafting

Course code: GM-677 **Credit Hours: 3**

Objectives: Study of various tools of computer drafting and their applications in GIS and Remote Sensing.

Course Outline: Introduction to engineering drawing/map, concept of lines, polgons, orthographic projection, projection of points, projection of lines, solids of revolution, introduction to Auto CAD map, drawing of 2D figure, drawing views of 3D Solids, Topology and Errors,.

Lab Outline: Introduction to CAD Environment, Concept of reference systems, unit systems, points, reference plane, Drawing Lines, poly lines, 2nd order curves, polygons, mirroring, Scaling, Stretching, Translation, Rotation, perspective projection, Orthographic projection, assembly drawing, cross-sectional areas, solid of revolution, shading, textures, rendering, etc.

Reference Material:

1. Sham Tickoo, AutoCAD 2004: A Problem Solving Approach
2. David Frey, AutoCAD 2005 and AutoCAD LT 2005: No Experience Required
3. Kunwoo Lee, Principles of CAD/CAM/CAE
4. Frederick E. Giesecke, Technical Drawing (12th Edition)
5. Frederick E. Giesecke, Principles of Engineering Graphics (2nd Edition)

Economic Geography

Course code: GM-678 **Credit Hours: 3**

Course Outline: Introduction: scope, status and importance of economic Geography, Dynamic nature of economic geography, Man's economic activities, exchange services and consumption. Environment: Man and his environment, adaptation of man to his environment, effect of environment on the economic life of man. Resources: Definition of resources, resources and wealth, Resistance and resources, Neutral stuff and resources, Classification of resources, functional theory of resources, resource creating factors, resource consciousness, the concept of conservation of resources. Human resources: Role of man, distribution of human resources, modern demographic trend, trend of world population, population density, optimum population, carrying capacity of land. Some recent concepts: Innovation and resource availability, the problem of ecological balance. Historical evolution of world system: Medieval Feudal economies, the rise of mercantilism, economic benefits from mercantilism, slave trade, Industrial revolution,

emergence of colonism, mechanism of modern world system. Agriculture economic activity: commercial agriculture, grain farming, dairing and mixed farming, livestock grazing
Fishing: Fish production, leading areas, International trade, Law of sea, Aquaculture. Forestry: Industrial timbering, global belts, water corridors, international trade. Mining: Features of mining and power mineral, Metallic and non-metallic mineral. Manufacturing: Types, distribution and location, heavy and light industries, high technology industry. Transport and communication: Meaning and types of transportation and communication. Trade: Definition, bases and types of trade, foreign trade, balance of trade and balance of payments, merits and demerits of trade

Reference Material:

1. Truman A. Hartshorn, J. Alexander W. (latest edition), "*Economic Geography"*
2. Sadhukhan, S. K: (latest edition), "*Economic Geography*", S.Chand co. Ltd. Delhi.
3. Khan, F. K: (latest edition), "*An introduction to Economic Geography",* Oxford university press, Karachi, Karachi.
4. Robert S.Pindyck & Danial L. Rubinfeld (Latest edition), "*Microeconomics*", 4e, Prentice Hall
5. Rudiger Dornbusch & Stanley Fischer (Latest edition), "*Microeconomics*", 6e, McGraw Hill
6. Samuleson & Nordhausan, "*Economics*",6e,Tata McGraw Hill
7. Saeed, Amjad Khawaja (latest edition), "*Economy of Pakistan".*
8. *Malik, Sohail (*latest edition), "*Economy of Pakistan".*
9. Waseer, Habibullah (latest edition)
10. "*Pakistan Economic Survey*" (various issues)

SEMESTER-8

Legal and Ethical Issues in Geomatics

Course code: GM-681 **Credit Hours: 3**

Objectives: This course will provide an understanding of emerging legal and ethical issues in Geomatics.

Course Outline: Introduction to the course, standardization of spatial objects, ethical issues, spatial areas, legal aspects of data, use data from other organizations, legal issues in vector data and raster data, reporting and controlling etc.

Reference Material:

1. Sammuel, J. (2009), "*Legal issues in GIS*", London, John Wiley.
2. Lillesand, T. M. and Kiefer, R. W. (2004), "*Remote Sensing and Image Interpretation*", 5th ed., John Wiley and Sons, ISBN 0-471-15227-7.

List of Elective courses

Application of Geomatics in Project Planning and Management

Course code: GM-682 **Credit Hours: 3**

Objectives: This course attempts to cover important aspects of Geomatics in project planning and management.

Course Outline: Introduction to course, uses and application of project planning and management**,** Geomatics and project organization, urban project planning, project identification, spatial data models, tools and techniques, Project planning process/ cycle, Appraisal of Projects, EIA and Geomatics, appraisal techniques, project implementation, monitoring and evaluation, preparation of final report.

Reference Material:

1. LittleI.M.D., Mirrlees, J.M. (1982), "*Project Appraisal and Planning for Developing Countries*", India, Oxford and IBH. ISBN: 0-435-84501-2
2. Merideth, J.R., Sammuel, J. Manbel (1989), "*Project Management"*, New York, John Wiley. ISBN: 0471-85319-4
3. Choudhry, S. Taha, (2000), "*Project Management*", India, McGraw Hill.ISBN: 0-13-032374-8

Advanced Geodatabase and Programming

Course code: GM-683 **Credit Hours: 3**

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

Reference Material

1. Menno-Jan Kraak (2008), "*Web Cartography*", Taylor & Francis ISBN: 074840869X
2. Simon W. Houlding (2000), "*Practical Geostatistics: Modeling and Spatial Analysis (with CD-ROM)*" Springer; Bk&CD Rom edition ISBN: 3540668209
3. Bruce Ralston (2002), "*Developing GIS Solutions with Map Objects and Visual Basic"* Onward Press, Thomson Learning, New York, ISBN: 0766854388
4. Kang-Tsung Chang Programming **(**2005), "*ArcObjects with VBA: A Task-Oriented Approach*", CRC Press LLC. ISBN**:** 0849327814
5. Philippe Rigaux, et al (2002), "*Spatial Databases: With Application to GIS (Morgan Kaufmann Series in Data Management Systems)*" Academic Press, U.S.

Biogeography

Course code: GM-684 **Credit Hours: 3**

Objectives: To study the 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 and history of Biogeography: Definition, relationship with other sciences, basic principles, scope and status, the age of exploration, biogeography in nineteenth and twentieth century, present day biogeography. Environmental setting: Earth's physical environments: Lithosphere, Hydrosphere, Atmosphere and the Biosphere, Geographic coordinate ecosystem, Geographic regions, mapping. The changing earth and Biogeographic processes: 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. Terrestrial biomes: 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. Hydro biomes: Fresh water biomes including rivers, streams, lakes and ponds. Marine Biomes including coastal, continental shelf and deep-sea biomes. Human-dominated biomes: 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 agro-ecosystems, conservation of environment in the urban and agro-ecosystems.

Reference Material:

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. (2003), "*Biomes of the earth: Terrestrial, aquatic and human dominated".* Greenwood press, U.S.A.

Calculus and Analytic Geometry

Course code: GM-685 **Credit Hours: 3**

Course Outline: Complex Numbers, DeMoivre's Theorem and its Applications, Simple Cartesian Curves, Functions and Graphs, Symmetrical Properties, Curve Tracing, Limit and Continuity, Differentiation of Functions. Derivative as Slope of Tangent to a Curve and as Rate of Change, Application to Tangent and Normal, Linearization, Maxima/Minima and Point of Inflexion, Taylor and Maclaurin Expansions and their convergence. Definite Integral as Limit of a Sum, Application to Area, Arc Length, Volume and Surface of Revolution. Reference Frames, Coordinate systems

Reference Material:

1. Ron Larson (2002), "*Calculus With Analytic Geometry*", Seventh Edition**.**
2. Ron Larson, Robert P. Hostetler, Bruce H. Edwards, Houghton Mifflin, (2004), "*Calculus with Analytic Geometry*", Seventh Edition.
3. George B., Jr. Thomas, Ross L. Finney; (2004), "*Calculus and Analytic Geometry*" 9th Ed., Amazon.
4. George Brinton Thomas, et al; Amazon,(2004) ,Thomas' Calculus (10th Edition).

5. Swokowski, Olinick and Pence (2004) Calculus and Analytical Geometry Amazon.
6. Sherman K Stein, Anthony, Amazon, (2002), Calculus and Analytic Geometry Amazon.

Discrete Mathematics and Linear Algebra

Course code: GM-686 **Credit Hours: 3**

Objectives: This course aims to develop understanding and appreciation of the finite nature inherent problems and structures through study of combinatorial reasoning, abstract algebra, iterative procedures, predicate calculus, tree and graph structures. Vectors, Vector Spaces, Matrices & Determinants, Linear Transformations, Operations on matrices, Inner products, Eigenvalues & Eigenvectors. Applications to Systems of Equations and to Geometry.

Course Outline: Sets, Combinatorics, Sequences, Formal logic, Prepositional and predicate calculus, Methods of Proof, Mathematical Induction and Recursion, loop invariants, Relations and functions, Pigeon whole principle, Trees and Graphs, Optimization and matching.

Reference Material:

1. Kenneth H Rosen, (2003), "*Discrete Mathematics and Its Applications"*, by Amazon.
2. Rosen, (2004), "*Discrete Mathematical Structures*".
3. David C Lay (2002), "*Linegyar Algebra"* 3rd Amazon.
4. David Poole, Amazon, 2003, "*Linear Algebra: A Modern Introduction".*
5. Gilbert Strang, 2003, "*Introduction to Linear Algebra*", 3rd Ed., Amazon
6. Seymour Lipschutz, Marc Lipson, 2002, "*Schaum's Easy Outline of Linear Algebra".*
7. Gareth Williams, 2004, "*Linear Algebra*", 5th Ed., Amazon
8. Richard Johnsonbaugh, 2004, "*Discrete Mathematics*", Amazon
9. Kenneth H Rosen; 2004, "*Discrete Mathematics and Its Applications"*, Amazon
10. Susanna S. Epp, 2004, "*Discrete Mathematics with Applications",* Amazon

Statistics and Probability

Course code: GM-687 **Credit Hours: 3**

Course Outline: Introduction to Statistics, Descriptive Statistics, Statistics in decision making, Graphical representation of Data Stem-and Lead plot, Box-Cox plots, Histograms and Ogive, measures of central tendencies, dispersion for grouped and ungrouped Data, Moments of frequency distribution; examples with real life, use of Elementary statistical packages for explanatory Data analysis. Counting techniques, definition of probability with classical and relative frequency and subjective approaches, sample space, events, laws of probability. Conditional probability and Bayesian theorem with application to Random variable (Discrete and continuous) Binomial, Poisson, Geometric, Negative Binomial Distributions; Exponential Gamma and Normal distributions.

Reference Material

1. Morris H. DeGroot, Mark J. Schervish, (2004), "*Amazon Probability and Statistics"* 3rd Ed.
2. Murray R Spiegel, et al, (2004), "*Schaum's Outline of Probability and Statistics"*, Amazon.
3. Ronald E. Walpole, et al; (2004), "*Probability and Statistics for Engineers and Scientists*", 7th Ed., Amazon.
4. Morris H. DeGroot, Mark J. Schervish, (2001), "*Probability and Statistics*" 3rd Ed., Amazon.

5. Walpole, (2000), "*Introduction to Statistics*".
6. Walpole, 7th Edition, (2002), "*Probability for Statistics for Engineers*".
7. Kreyszig, E., 8th Edition, (2003), "*Advanced Engineering Mathematics*".

Land Information System

Course code: GM-688 **Credit Hours: 3**

Objectives: This course attempts to give students a broad understanding of land tenure and the cadastre concept, how it has evolved historically and its role in documenting land rights. The course covers cadastral systems in the world as a means of understanding fundamental principles and design criteria underlying these systems. The final part of the course deals with the design of cadastre-based LIS.

Course Outline: Introduction to Land characteristics, Land information system, Cadastre, Land information management, LIS Taxonomy, classification of land information , Land Registration, Comparison of land registration and cadastre, Benefits of land registration for individuals and role of land registration for Government, Land Tenure Systems, Concept and definition, Forms of land tenure operational forms of land tenure, English, Anglo-American, Continental, Western European Concept and rights, Customary land tenure Islamic land tenure, Land Registration concept, process, Public registration, Principles of \registration, Deeds Registration, Title Registration, Features of Land Registration system, Private conveyancing, Positive and Negative Systems, Boundaries, Fiscal cadastre Multipurpose Cadastre, Institutional arrangement and technical matters, Procedures for introducing a land administration system.

Lab Outline: Studying and understanding the existing LIS examples, Development of work flow diagrams for the procedures, Comparison of existing land information systems, Cadastral mapping through existing analogue maps/satellite imageries, Cadastral map editing, and updating, Development of database for land registration, Process verification and development of Registries, Titles, Integration of Revenue mapping and statistical analysis, Integration of cadastral system with other utility information system, LIS Project Development

Reference Material:

1. Flower, C. (1998) "*Geographic information systems, mapping, and spatial data for the coastal and ocean resource management community*", NOAA's Coastal Services Canter.
2. Dale, P.F. and J. McLaughlin (1988), "*Land Information Management*", Oxford University Press, New York.
3. United Nations (1996), "*Land Administration Guidelines: with special reference to countries in transition*", New York & Geneva.

Advanced Remote Sensing Applications

Course code: GM-689 **Credit Hours: 3**

Objectives: To make students understand in using high-resolution multispectral data, sophisticated image processing softwares, theory and application of image processing techniques.

Course Outline: Introduction to advanced remote sensing, Remote sensing and earth energy budget, Electromagnetic spectrum and radiation, Physical foundation of Visible, Infrared and microwaves remote sensing, high and low resolution remote sensing, Theoretical explanation of reflection, absorption and transmission, High resolution multi-spectral data, advanced image processing softwares, Theory and application of image processing techniques, Accuracy testing,

Height measurement techniques, Area measurement techniques, image enhancements: Geometric data correction, atmospheric data correction, radio-metric data correction, transformations and classification.

Reference:

1. Aronoff, S. (2005) "*Remote Sensing for GIS Managers*". ESRI Press, New York.
2. Canada Centre for Remote Sensing (2005) "*Fundamentals of remote sensing*". Remote Sensing Tutorial, Natural Resources, Canada.
3. Carleton .A. (1990) "*Satellite Remote sensing in climatology*". CBS publishers and distributor, New Delhi
4. Carter D.J. (1986) "*The remote sensing*". Mc Carta LTD, London
5. Davis .S. (Latest version) "*Remote sensing the Quantitative approach*". McGraw-Hill New York
6. European Space Agency (1988) "*Remote sensing moving towards the 21st century*". Proceeding of international geosciences and Remote sensing Symposium.12-16 September 1988 volume I, Edinburgh U.K.
7. Lillesand, T. M. (2006) "*Remote sensing and image interpretation*". John Wiley & Sons, Inc. New York
8. Michael H.R. (1986) "*Remote Sensing method and application*". John Wiley and sons Inc. New York.