Hydrology and Water Resources Engineering: K. C. Patra Ground Water Hydrology: David Keith Todd.
Snow and Glacier Hydrology: Kayee Brubaker.
Hydroinformatics Tools, 1998.Jiri ,Marasalak, Cedo, Maksimovic, EvzenZaman. Kluwer Academic Publishers.

GI17304DCE: TERM WORK

Topics for dissertation research work will be given to the students and they will be asked to make a synopsis presentation which would orient them with respect to the basic aims, objectives and tentative methodology to carry out their proposed work. Further, a mid-semester review presentation will be conducted in order to assess the progress of the students

GI17305DCE: GLACIOLOGY

Coarse goals

- To explores the nature and the dynamics of glaciers.
- To understand the Himalayan Cryosphere and problems these glaciers are facing.

Unit-I
Glaciers: Glacier Formation, glacier features and types. Movement of glaciers.Glacial deposits.Glacial and interglacial periods.Glacial landform. Last Glacial Maximum, Little Ice Age, Younger Dryas. Climate change and glaciers. Glaciers resources of Kashmir

Unit-II
Glacier dynamics: ELA, AAR, velocity; Mass balance studies of glaciers; geological, photogrammetric, GPS/GPR mass balance. Use of remote sensing for snow and glacier studies, glacier (snow cover, snow depth, snow water equivalence, snow density). Snow depletion curves.

Unit-III: Himalayan Glaciers
Snow and glacier resources of Kashmir.Climate change and glaciers. Snow hydrology, snowmelt runoff modeling. Black carbon deposition on glaciers and its impacts on melting, and other feedbacks. Impacts of changing Himalayan cryosphere on political stability in south Asia.

Books recommended
Bennett, M. R. and Glasser, N. F., 2000.Glacial Geology Ice Sheets and Landforms. Wiley Sharp,
M., Richards, K. S. and Tranter M., 1998.Glacier Hyrology and Hydrochemistry. Wiley Allan, T. D.: Satellite microwave remote sensing.Chichester, Ellis Hardwood.
BennD.I. and EvansJ A D., 1997. Glaciers and Glaciation.Woody's Books USA
Hubbard, B. and Glasser N. F. 2005.Field Techniques in Glaciology and Glacial Geomorphology. Wiley

GI17306DCE: EARTH SYSTEM SCIENCE

Coarse goal

- To facilitate thinking in terms of systems concepts
- To explore the complexity of relationships between the major subsystems of the earth.

Hydrology and Water Resources Engineering: K. C. Patra Ground Water Hydrology: David Keith Todd.
Snow and Glacier Hydrology: Kayee Brubaker.
Hydroinformatics Tools, 1998.Jiri ,Marasalak, Cedo, Maksimovic, EvzenZaman. Kluwer Academic Publishers.

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M., Richards, K. S. and Tranter M., 1998.Glacier Hyrology and Hydrochemistry. Wiley Allan, T. D.: Satellite microwave remote sensing.Chichester, Ellis Hardwood.
BennD.I. and EvansJ A D., 1997. Glaciers and Glaciation.Woody's Books USA
Hubbard, B. and Glasser N. F. 2005.Field Techniques in Glaciology and Glacial Geomorphology. Wiley

GI17306DCE: EARTH SYSTEM SCIENCE

Coarse goal

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References

A review of Statistical Spatial analysis in geographical information system, Bailey, T.C 1994 Taylor and Francis.
Quantitative Geography: Perspective on Spatial data Analysis, Fortheringham A.S.2000 Sqage Publications.
Spatial Analytical Prospective on GIS, London, Fischer,M.,Scholten.Taylor and Francis.
Dynamic Modelling and Geocomputation.
Burrrough, Peter A.1998.A Primer, P. Longley,S.Brooks,B.Macmillan,andR.McDonnell(eds),pp 165-192,New York Wiley.
Fundamentals of spatial information systems, Laurini, R and Thompson, D: Academic Press London.
Exploring spatial analysis in geographical information systems, Chou, Y. H.: Onward Press, New Mexico, US

GI17303CR: HYDROINFORMATICS

Coarse goals

- To assess and manage the water resources vis-a-vis the application of Geoinformatics.
- To learn to develop site specific strategies or plans for water resource management using the Geoinformatics.
- To enable theidentification and management of potential ground water resources.

Unit I: Hydrological Cycle and Processes: Hydrological cycle and processes: precipitation, evaporation, transpiration, interception, infiltration, percolation and groundwater recharge. Hydrometeorology: stream flow and precipitation measurement and Statistical methods for the analysis of stream flow and precipitation data, runoff–flow duration curve, flow mass curve, hydrograph – its components.

Unit II: Remote Sensing for Surface and Ground Water: Remote sensing techniques for water resources assessment: Interpretation of satellite data for water resources, impact of spatial resolution on water resources mapping. Surface water bodies mapping (visual interpretation and digital image processing for mapping irrigation tanks, ponds, reservoirs, lakes etc.).Role of remote sensing for quantifying the hydrological processes.Groundwater exploration using remote sensing and GIS.

Unit III: Geoinformatics for Watershed Management: Watershed characterization and hydrological modelling. Concept of Runoff and overland flow, Factors affecting runoff processes. Watershed factors that affect runoff: size, topography, shape, orientation, aspect, geology, soil interflow and base flow. DEM applications in water resources.Watershed management, planning and conservation principles.Geoinformatics for watershed management.

Unit IV: Snow and Glacier Studies using Geoinformatics: Visible, infrared and microwave remote sensing for snow and glacier studies. Normalized Difference Snow Index (NDSI) and other ratio methods for snow/glacier mapping. Snow hydrology, snowmelt run-off modeling. Glacier inventory (areal extent, depth) Change detection studies of glaciers. Mass balance studies of glaciers using geological, geodetic and hydrological approaches.

References

Hand Book of Applied Hydrology: (Ed) Ven T. Chow Water Resources Engineering: Linsley and Franzin Remote Sensing in Hydrology: E.T. Engman& R.J. Gurney Elementary Hydrology: V. P. Singh.
Principles of Water Resources Planning: Alvin, S. Goodman.
Freshwater Ecology (Concepts and Environmental Applications): Walter K. Dodds Environmental Hydrology: Andy D. Ward and Stanley W. Trimble.

Hydrology and Water Resources Engineering: K. C. Patra Ground Water Hydrology: David Keith Todd.
Snow and Glacier Hydrology: Kayee Brubaker.
Hydroinformatics Tools, 1998.Jiri ,Marasalak, Cedo, Maksimovic, EvzenZaman. Kluwer Academic Publishers.

GI17304DCE: TERM WORK

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GI17305DCE: GLACIOLOGY

Coarse goals

- To explores the nature and the dynamics of glaciers.-
- To understand the Himalayan Cryosphere and problems these glaciers are facing.

Unit-I
Glaciers: Glacier Formation, glacier features and types. Movement of glaciers.Glacial deposits.Glacial and interglacial periods.Glacial landform. Last Glacial Maximum, Little Ice Age, Younger Dryas. Climate change and glaciers. Glaciers resources of Kashmir

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Glacier dynamics: ELA, AAR, velocity; Mass balance studies of glaciers; geological, photogrammetric, GPS/GPR mass balance. Use of remote sensing for snow and glacier studies, glacier (snow cover, snow depth, snow water equivalence, snow density). Snow depletion curves.

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M., Richards, K. S. and Tranter M., 1998.Glacier Hyrology and Hydrochemistry. Wiley Allan, T. D.: Satellite microwave remote sensing.Chichester, Ellis Hardwood.
BennD.I. and EvansJ A D., 1997. Glaciers and Glaciation.Woody's Books USA
Hubbard, B. and Glasser N. F. 2005.Field Techniques in Glaciology and Glacial Geomorphology. Wiley

GI17306DCE: EARTH SYSTEM SCIENCE

Coarse goal

- To facilitate thinking in terms of systems concepts
- To explore the complexity of relationships between the major subsystems of the earth.

Unit-I: Earth System System concept for earth system science. Components of the geosphere and environment - lithosphere, biosphere, hydrosphere and atmosphere, Hydrologic cycle, Energy balance.

Unit-II: Relationships between the major subsystems
Biogeochemical cycles - nitrogen cycle, carbon cycle and phosphorous cycle. Long-term evolution of earth system. Quaternary environmental changes, Atmosphere-ocean interactions, El Niño-Southern Oscillation, evidence for global warming, Paleoclimate proxies.

Books recommended:

Gass I.G. et al 1982: Understanding the Earth. Artemis Press (Pvt.) Ltd. U.K.
Windley B. 1973: The Evolving continents. John Wiley & Sons, New York.
Condie, Kent. C. 1982. Plate Tectonics and Crystal Evolution Pergamon Press Inc.
Gansser, A.Geology Of Himlayas, Cox , Plate Tectonicsa and Geotectonic reversal, Heim and Gansser, Central Himalaya,
Sinha, A. K., Sassi, F. P. and Papinikolaou, D., 1997. Geodynamic domains in the Alpine- Himalayan Tethys,
Sharma, K. K., 1991. Geology and Geodynamic evolution of the Himalayan CollissionZone.Thakur, V. C. and Sharma, K. K., 1983.Geology of the Indus Suture Zone of Ladakh.

GI17307GE: MAPPING IN GIS

Course Goals:

- To make students familiar with earth observation data analysis.
- To help students in accessing globally available geospatial data repositories
- To expose students to basics of mapping using GIS platforms.

Unit-I: Fundamentals of mapping
National Mapping standards - NNRMS and its importance.Levels of classification from earth observation data.NNRMS standards from land cover and vegetation mapping.Basic components of a map and concept of scale in mapping. Data sources for mapping: remote sensing, field observations, GPS, maps and other ancillary data. Hands-on GIS: Creation of point, line and polygon theme).

Unit-II: Basics of Geospatial Analysis
Elements of image interpretation. Web-portals for data download: Bhuvan and Earth Explorer. Delineating land use land cover from earth observation data: Opportunities and challenges. Ground truth procedure and ground data collection pertaining to land cover and vegetation. Hands-on GIS: Land cover mapping, Map making and Accuracy assessment.

Books recommended

Burrough, P. A. 1996. Principles of Geographic Information Systems for land resources assessment, Oxford: Clarendon Press.
De Mers, M. N. 2002. Fundamentals of Geographic Information Systems. John Wiley and Sons, New York.
Ormeling, F., &Kraak, M. J. 2010. Cartography: Visualization of Geospatial Data. Prentice Hall.
Robinson, Arthur H., JoelL. Morrison, Phillip C. Muehrcke, A. Jon Kimerling, and Stephen C. Guptill 1995.Elements of Cartography, John Wiley and Sons, New York.

visualization.

References:

Anita Graser. (2016). Learning QGIS - Third Edition. Packt Publishing, Birmingham UK.
Kurt Menke, Richard Smith Jr., Luigi Pirelli, John Van Hoesen. (2015). Mastering QGIS - Second Edition. Packt Publishing, Birmingham UK.
Jesse Russell, Ronald Cohn. (2012). ILWIS.Book on Demand, Berlin Germany.

GI17404DCE: GEOMORPHOLOGY FROM SPACE

Coarse goal

- To understand the dominant process shaping a particular landscape.
- To be able to identify landforms using the remote sensing technology.

Unit I:**Fluvial Landforms:** Introduction to Fluvial landforms; Types; Drainage Systems; Drainage Basins; Drainage Patterns; Flood Plains and Terraces; Paleochannels.

Unit II: Landform Mapping: Introduction to Landform mapping. Geomorphological mapping theory and development and diversity.Introduction to Geomorphic Mapping; Role of Remote Sensing in mapping, Geomorphic mapping analysis.

References

Nicholas M. Short, Sr. and Robert W. Blair 1986: Geomorphology from Space is an out of print 1986 NASA publication.
Bloom, A. L., 2002: Geomorphology, A Systematic Analysis of L. Cenozoic Land Forms. Prentice Hall Pvt. Ltd., N. Delhi.
Burbank, D. W. and Anderson, R.S., 2001: Tectonic Geomorphology Blackwell Sciences
Easterbrook, Easterbrook, 1994: Surface Processes and Land Forms. Prentice Hall.
McCalpin, J., 1996: Paleoseismology Academic Press.
Pitty, A. F, 1982: Nature of Geo-Morphology. University Paper Backs. Ritter, D. F., 1978: Process Geomorphology. Wm. C. Brown Publishers, Lowa Sharma, V. K., 1986: Geomorphology. Tata McGraw Hill. Thorrenberry, W. D., 1997: Principles of Geomorphology New Age International, Delhi.
Vishwas, S. K and Gupta, A., 2001: Introduction to Geomorphology Orient Longman

GI17405DCE: CLIMATOLOGY ANDCLIMATE CHANGE

Coarse goal

- To give a basic understanding of climate and its variables.
- To understand the process of climate change and its impacts.

Unit I: Atmospheric Layers and Thermal Variation: Nature, composition and layered structure of the atmosphere. Factors controlling insolation; heat budget of the atmosphere.Horizontal and vertical distribution of temperature; Inversion of temperature.Green house effect and importance of ozone layer.

Unit 11 Atmospheric Layers and Wind Circulation: Global atmospheric pressure belts and their oscillation. General wind circulation.Jet stream and index cycle.Monsoon mechanism with reference to jet stream.General.Synoptic weather forecasting, prediction of weather elements such as rain.maximum and minimum temperature and fog; hazardous weather elements like thunderstorms, Dust storms.

visualization.

References:

Anita Graser. (2016). Learning QGIS - Third Edition. Packt Publishing, Birmingham UK.
Kurt Menke, Richard Smith Jr., Luigi Pirelli, John Van Hoesen. (2015). Mastering QGIS - Second Edition. Packt Publishing, Birmingham UK.
Jesse Russell, Ronald Cohn. (2012). ILWIS.Book on Demand, Berlin Germany.

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Nicholas M. Short, Sr. and Robert W. Blair 1986: Geomorphology from Space is an out of print 1986 NASA publication.
Bloom, A. L., 2002: Geomorphology, A Systematic Analysis of L. Cenozoic Land Forms. Prentice Hall Pvt. Ltd., N. Delhi.
Burbank, D. W. and Anderson, R.S., 2001: Tectonic Geomorphology Blackwell Sciences
Easterbrook, Easterbrook, 1994: Surface Processes and Land Forms. Prentice Hall.
McCalpin, J., 1996: Paleoseismology Academic Press.
Pitty, A. F, 1982: Nature of Geo-Morphology. University Paper Backs. Ritter, D. F., 1978: Process Geomorphology. Wm. C. Brown Publishers, Lowa Sharma, V. K., 1986: Geomorphology. Tata McGraw Hill. Thorrenberry, W. D., 1997: Principles of Geomorphology New Age International, Delhi.
Vishwas, S. K and Gupta, A., 2001: Introduction to Geomorphology Orient Longman

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Unit 11 Atmospheric Layers and Wind Circulation: Global atmospheric pressure belts and their oscillation. General wind circulation.Jet stream and index cycle.Monsoon mechanism with reference to jet stream.General.Synoptic weather forecasting, prediction of weather elements such as rain.maximum and minimum temperature and fog; hazardous weather elements like thunderstorms, Dust storms.

Unit III Circulation Models (GCM); Regional Climate Models; IPCCC climate Change scenarios. Climate Change Impact Studies; glaciers; water resources; food security; downscaling andupscaling of climate data; Paleo-climate inference from lake sediments, ice-core; paleosols.

References

D.S. Lal ClimatologyShardaPustakBhawan, 2003,ISBN 8186204121, 9788186204122
Howard J. Critchfield, 1996. General Climatology Prentice-Hall, Englewood Cliffs, N.
Climate Modelling Primer, Third Edition, K. McGuffie and A. Henderson-Sellers, John Wiley & Sons, Ltd., 2005.
Atmospheric Science: An Introductory Survey, Second Edition, J. M. Wallace and P. V. Hobbs, Academic Press, 2006.
Climatology, R. V. Rohli and A. J. Vega, Jones and Bartlett Publishers, 2008.
Meteorology Today: An Introduction to Weather, Climate, and The Environment, Ninth Edition, C. D. Ahrens, Brooks/Cole, 2009.
Climate System Modeling, K. E. Trenberth, QC 981 C65 1992. Physics of Climate, J. Peixoto, QC 981 P.434 1992.
Storm and Storm Dynamics, W. R. Cotton and R. A. Anthes, Academic Press, 1989.Mesoscale Meteorological Modelling, 2nd Edition, R. A. Pielke, Sr., Academic Press, 2002.
Ecological Climatology: Concepts and Applications, Second Edition, Gordon B. Bonan, Cambridge University Press, pp. 678, 2008.

GI17406DCE: ADVANCED REMOTE SENSINGAND GIS

Coarse goal

- To introduce students with advanced topics in digital remote sensing
- To learn in depth insights into theoretical and conceptual underpinnings in satellite remote sensing

Unit 1: Digital Image Processing : Hyper-spectral Image processing; Image Fusion; Band Rationing in Digital Image Processing; Integration of multi-sensor data: introduction, technique, constraints and applications. Basic pattern recognition concepts, Principles of spectral discrimination

Unit II: Image Statistics: Multivariate image statistics, Optical remote sensing data filters, radar speckle/noise removal techniques, Pattern recognition, boundary detection and representation, textural and contextual analysis. Classification accuracy assessment. Hybrid training, Non- parametric, and sub-pixel classification, Hyper – spectral image analysis and feature based classification

Unit III: Remote sensing Applications: Geological mapping (lithology, structural mapping of faults and folds). Use of remote sensing data for snow and glacier mapping, change detection studies (deforestation), Remote sensing for crustal deformation and hydrological analysis

References

Campbell, J., 2002: Introduction to Remote Sensing. Guilford Press, New York. Demers, M. N., 1999: Fundamentals of Geographic Information Systems. John Wiley.
John, A., Richards, 1993: Remote Sensing Digital Image Analysis. Springer-Verlag. John, R., Jensen, 2000: Introductory Digital Image Processing, A Remote Sensing
Perspective.
Lillesand, T. M. and Kiefer, R W., 1987: Remote Sensing in Geology. J. Wiley. Prentice Hall.
Lillesand, T. M. and Kiefer, RW, 2002: Remote Sensing and Image Interpretation, John Wiley.
Rees, W. G., 2001: Physical Principles of Remote sensing. Cambridge Uni. Press.Sabbins, F. F., 1985: Remote Sensing - Principles and Applications.
Freeman Skidmore, A., 2002.Environmental modeling with GIS & Remote Sensing. T& F, London.

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Lillesand, T. M. and Kiefer, RW, 2002: Remote Sensing and Image Interpretation, John Wiley.
Rees, W. G., 2001: Physical Principles of Remote sensing. Cambridge Uni. Press.Sabbins, F. F., 1985: Remote Sensing - Principles and Applications.
Freeman Skidmore, A., 2002.Environmental modeling with GIS & Remote Sensing. T& F, London.

Concept of data, examples of GIS; Geographic data sources (Remote Sensing, GPS, Maps and Field observations). Spatial and non-spatial data: introduction, importance and integration.

Unit II: Databases and Data Models
Data models: Concept and types, Raster data model, Vector data model, Advantages and disadvantages of raster and vector data models, issue related to data model conversation. Data errors, data editing. Concept and applications of Topology in GIS.

Unit III: Geospatial Data Analysis
Geospatial analysis: Introduction, vector-based analysis (Non- topological and topological functions with examples of each type), Raster based analysis (Local operations, neighbourhood operations, extended neighbourhood operations, regional operations with examples of each type).

Books recommended:
Burrough, P. A. 1996. Principles of Geographic Information Systems for land resources assessment, Oxford: Clarendon Press.
Demer, Michael, N. 2000. Fundamentals of Geographic Information Systems, JW and Sons.
Chang, K. 2004. Introduction to GIS, McGraw-Hill, Dubuque, Iowa.
Clarke, K. C. 2003. Getting Started with Geographical Information Systems, Prentice Hall, Upper Saddle River, New Jersey.
De Mers, M. N. 2002. Fundamentals of Geographic Information Systems**.** John Wiley and Sons, New York.
Chrisman, N. 2002. Exploring Geographic Information Systems**,** J W and Sons

GIP17103CR: Practical-Geospatial analysis

- Familiarization with GIS software systems
- Data input; digitization, scanning
- Data editing of spatial and non-spatial data
- Use of attributes and other tabular data
- Database creation, linking, joining and registration
- Geo-processing of geospatial data like buffering, proximity analysis etc.
- Data query and preliminary data analysis
- Map making and production

GI17104DCE: CARTOGRAPHY AND GEOINFORMATION VISUALIZATION

Course Goals
- Expose students to the basic and advanced techniques of digital cartography for visual exploration and presentation of the geo-information data.
- Develop map design, composition and editing skills
- Teach techniques for Integration of thematic, spatial and non-spatial data at various scales

Unit I: Map Making
Maps: Introduction, types of maps, uses of maps. Cartography: analogue and digital cartography, cartographic generalizations. Map composition: map design and layout, map scale, legend, annotations. Coordinate systems, Geoid, shape of earth and datums, Map projections: introduction, properties and aspects of map projections, classification of map projections.

Unit II: Data Sources and Visualization
Data sources for mapping: remote sensing, field observations, GPS, maps and other ancillary data.

Survey of India (SOI) map index and National Mapping Policy, Use and users of geo-spatial data, Data products w.r.t land surface processes, disasters, EIA and geology. DEM, need, methods, data sources and products, Visualization techniques: Visual exploration for different features/surfaces, virtual reality and scenario mapping. Lidar, Stereo-images, Aerial photos and InSAR.

Unit III: Statistical Data Analysis
Measurement Scales: nominal, ordinal, interval, and ratio. Measures of central tendency: mean, median, mode, Measures of Dispersion: range, Variance, standard deviation, coefficient of variation, skewness and kurtosis. Regression and correlation analysis. Basic concepts of time series data analysis.

Unit IV: Data Presentation
Geospatial data dissemination: maps, graphics, animations, multi- media, internet and posters. Quantitative representation of spatial and non-spatial data. Digital and cartographical and scape models. Exaggerations and omissions. Map updating using GPS and Remote Sensing data. Assessing the accuracy of maps.

Books recommended:
Ormeling, F., & Kraak, M. J. 2010. Cartography: Visualization of Geospatial Data. Prentice Hall.
Robinson, Arthur H., JoelL. Morrison, Phillip C. Muehrcke, A. Jon Kimerling, and Stephen C. Guptill 1995. Elements of Cartography, John Wiley and Sons, New York.
Laurini, R., & Thompson, D. 1992. Fundamentals of spatial information systems. Academic press. London.
Longley, Paul A., M.F. Goodchild, D.J. Maguire, and D. W. Rhind 2005. Geographic Information Systems and Science, John Wiley and Sons, New York.
DeMers, Michael N 2008. Fundamentals of geographic information systems, John Wiley & Sons
Richard K. Brail, and Richard E. Klosterman 2001. Planning Support Systems: Integrating Geographic Information Systems, Models, and Visualization Tools, ESRI Press.
Lo, C. P. & Yeung, A. K. 2007. Concepts and techniques of geographic information systems, Pearson Prentice Hall.

GI17105DCE: APPLICATIONS OF REMOTE SENSING AND GIS

Course Goals
- Familiarize students with the basic and advanced applications of geoinformatics
- Expose students to basic methodologies of remote sensing and GIS for environmental monitoring

Unit I: GIS Applications and Case Studies
Utility mapping using GIS, Wildlife habitat analysis, Land suitability analysis, Geoinformatics for Environmental impact analysis (EIA), Disaster vulnerability analysis (seismic micro zonation, landslide hazard zonation), Geoinformatics for Land information System (LIS).

Unit II: Geospatial Modeling and Applications
Geospatial Modeling: introduction, importance and techniques. Land degradation modeling, watershed prioritization. Hydrological modeling, flood vulnerability zonation. Environmental modeling: Integrated Environmental analysis and assessment of Carrying Capacity using GIS, Eco-zonation mapping. Crop growth modelling in GIS environment.

Unit III: Remote Sensing Applications
Role of Remote Sensing in Landslide mapping, Flood and Agriculture management/monitoring. Land use/land cover mapping and monitoring, Urbanization (urban land use, urban sprawl). Role of Remote Sensing in Fishery and wildlife application.

Survey of India (SOI) map index and National Mapping Policy, Use and users of geo-spatial data, Data products w.r.t land surface processes, disasters, EIA and geology. DEM, need, methods, data sources and products, Visualization techniques: Visual exploration for different features/surfaces, virtual reality and scenario mapping. Lidar, Stereo-images, Aerial photos and InSAR.

Unit III: Statistical Data Analysis
Measurement Scales: nominal, ordinal, interval, and ratio. Measures of central tendency: mean, median, mode, Measures of Dispersion: range, Variance, standard deviation, coefficient of variation, skewness and kurtosis. Regression and correlation analysis. Basic concepts of time series data analysis.

Unit IV: Data Presentation
Geospatial data dissemination: maps, graphics, animations, multi- media, internet and posters. Quantitative representation of spatial and non-spatial data. Digital and cartographical and scape models. Exaggerations and omissions. Map updating using GPS and Remote Sensing data. Assessing the accuracy of maps.

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Robinson, Arthur H., JoelL. Morrison, Phillip C. Muehrcke, A. Jon Kimerling, and Stephen C. Guptill 1995. Elements of Cartography, John Wiley and Sons, New York.
Laurini, R., & Thompson, D. 1992. Fundamentals of spatial information systems. Academic press. London.
Longley, Paul A., M.F. Goodchild, D.J. Maguire, and D. W. Rhind 2005. Geographic Information Systems and Science, John Wiley and Sons, New York.
DeMers, Michael N 2008. Fundamentals of geographic information systems, John Wiley & Sons
Richard K. Brail, and Richard E. Klosterman 2001. Planning Support Systems: Integrating Geographic Information Systems, Models, and Visualization Tools, ESRI Press.
Lo, C. P. & Yeung, A. K. 2007. Concepts and techniques of geographic information systems, Pearson Prentice Hall.

GI17105DCE: APPLICATIONS OF REMOTE SENSING AND GIS

Course Goals
- Familiarize students with the basic and advanced applications of geoinformatics
- Expose students to basic methodologies of remote sensing and GIS for environmental monitoring

Unit I: GIS Applications and Case Studies
Utility mapping using GIS, Wildlife habitat analysis, Land suitability analysis, Geoinformatics for Environmental impact analysis (EIA), Disaster vulnerability analysis (seismic micro zonation, landslide hazard zonation), Geoinformatics for Land information System (LIS).

Unit II: Geospatial Modeling and Applications
Geospatial Modeling: introduction, importance and techniques. Land degradation modeling, watershed prioritization. Hydrological modeling, flood vulnerability zonation. Environmental modeling: Integrated Environmental analysis and assessment of Carrying Capacity using GIS, Eco-zonation mapping. Crop growth modelling in GIS environment.

Unit III: Remote Sensing Applications
Role of Remote Sensing in Landslide mapping, Flood and Agriculture management/monitoring. Land use/land cover mapping and monitoring, Urbanization (urban land use, urban sprawl). Role of Remote Sensing in Fishery and wildlife application.

Unit IV: Advanced Applications of Remote Sensing
Vegetation applications (Deforestation, Net primary productivity estimation, Leaf area index. Cadastral mapping. Geological applications (lithology, tectonics). Water resources management (snow and glaciers, ground water exploitation) Environmental evaluation and monitoring (wetlands, desertification)

Books recommended:
DeMers, M. N. 2003. Fundamentals of geographic information systems. J. Wiley.
Chrisman, N. 2002. Exploring Geographic Information Systems, J W and Sons, New York.
Cracknell, A. P and Hayes, L.W.B. 1993. Introduction to Remote Sensing, Taylor and Francis London.
Colwell, R. N. 1983. Manual of remote sensing. American Society of Photogrammetry.
Jensen, John R. 2004. Introductory Digital Image Processing, Prentice Hall.

GI 17106 DCE: SURVEYING TECHNIQUES

Course Goals:
- To make students understand the importance of surveying in earth sciences
- To make students understand the applications of basic surveying instruments.

Unit I: Basics of Surveying
Introduction to surveying. Key concepts and principles of Surveying. Designing surveys, processing of survey data, Process of Map Making, Data sources for mapping: remote sensing, field observations, GPS, maps and other ancillary data.

Unit II: Sampling and sampling design
Introduction to sampling. Probability sampling; Simple Random sampling, Systematic sampling and Stratified sampling. Methods of computer assisted data collection.

Unit III: Modern survey methods
Modern surveying electronic equipments: digital levels, digital theodolites, EDMs, Total stations; Principles, working and applications; Lasers in surveying, GPS working principles and components.

Unit IV: Remote Sensing and GIS based Surveys
Remote Sensing principles, components as a tool for data generation and mapping; Introduction to modern techniques – Air photographs and Satellite Imagery and their basic properties, concept of GIS and GPS and their components, Types, scales and ground coverage. Advantages of Aerial photographs over conventional on-the-ground observations.

Tutorial
- GPS survey of the University Campus or Dal Lake, Shalimar/Nishat garden.
- Validation of the Satellite based Digital Elevation Model with the GPS data.
- Accuracy assessment of the satellite based land use and land cover data.

Books recommended:
Leick A. 1995. GPS Satellite Surveying, Wiley, Newyork Chicheste Brisbane Toronto Singapore.
Hofmann-Wellenhof B, Lichtenegger H. 2007. GPS Theory and Practice, Springer (5^{th}eds), Wien New York.
Kennedy, M. Ann Arbor, M. I. 2002. Global Positioning System and GIS, CRC Press.
Kraak, M. J., & Ormeling, F. 2003. Cartography: Visualization of geospatial data. Harlow.
Robinson, Arthur H., JoelL. Morrison, Phillip C., Muehrcke A. Jon Kimerling, and Stephen C 1984. Elements of Cartography, John Wiley and Sons, New York.

Unit IV: Advanced Applications of Remote Sensing
Vegetation applications (Deforestation, Net primary productivity estimation, Leaf area index. Cadastral mapping. Geological applications (lithology, tectonics). Water resources management (snow and glaciers, ground water exploitation) Environmental evaluation and monitoring (wetlands, desertification)

Books recommended:
DeMers, M. N. 2003. Fundamentals of geographic information systems. J. Wiley.
Chrisman, N. 2002. Exploring Geographic Information Systems, J W and Sons, New York.
Cracknell, A. P and Hayes, L.W.B. 1993. Introduction to Remote Sensing, Taylor and Francis London.
Colwell, R. N. 1983. Manual of remote sensing. American Society of Photogrammetry.
Jensen, John R. 2004. Introductory Digital Image Processing, Prentice Hall.

GI 17106 DCE: SURVEYING TECHNIQUES

Course Goals:
- To make students understand the importance of surveying in earth sciences
- To make students understand the applications of basic surveying instruments.

Unit I: Basics of Surveying
Introduction to surveying. Key concepts and principles of Surveying. Designing surveys, processing of survey data, Process of Map Making, Data sources for mapping: remote sensing, field observations, GPS, maps and other ancillary data.

Unit II: Sampling and sampling design
Introduction to sampling. Probability sampling; Simple Random sampling, Systematic sampling and Stratified sampling. Methods of computer assisted data collection.

Unit III: Modern survey methods
Modern surveying electronic equipments: digital levels, digital theodolites, EDMs, Total stations; Principles, working and applications; Lasers in surveying, GPS working principles and components.

Unit IV: Remote Sensing and GIS based Surveys
Remote Sensing principles, components as a tool for data generation and mapping; Introduction to modern techniques – Air photographs and Satellite Imagery and their basic properties, concept of GIS and GPS and their components, Types, scales and ground coverage. Advantages of Aerial photographs over conventional on-the-ground observations.

Tutorial
- GPS survey of the University Campus or Dal Lake, Shalimar/Nishat garden.
- Validation of the Satellite based Digital Elevation Model with the GPS data.
- Accuracy assessment of the satellite based land use and land cover data.

Books recommended:
Leick A. 1995. GPS Satellite Surveying, Wiley, Newyork Chicheste Brisbane Toronto Singapore.
Hofmann-Wellenhof B, Lichtenegger H. 2007. GPS Theory and Practice, Springer (5^{th}eds), Wien New York.
Kennedy, M. Ann Arbor, M. I. 2002. Global Positioning System and GIS, CRC Press.
Kraak, M. J., & Ormeling, F. 2003. Cartography: Visualization of geospatial data. Harlow.
Robinson, Arthur H., JoelL. Morrison, Phillip C., Muehrcke A. Jon Kimerling, and Stephen C 1984. Elements of Cartography, John Wiley and Sons, New York.

GI17203CR: ADVANCED GEOINFORMATICS

Course Goals

- Imparting advanced concepts of geo-informatics, GNSS, GPS
- Development of skills in the use of geo-information technology for modelling land surface processes.

Unit I: Contemporary Issues in Geoinformatics

Emerging trends and scope of Geoinformatics. Technological advancements in Geoinformatics, Information Technology and Sensor technology. Data standardization: Data standards, data quality, Scale issues in RS and GIS. GIS design methodology, design and implementation, technical, manpower and institutional issues.

Unit II: Recent advancements in Geoinformatic Science and applications

Enterprise Geographic Information System (GIS): definition trends, implementation and its applications. GPS data use and importance in geospatial analysis. Data integration in GIS: Socio-economic GIS, integration and application of socio-economic and environmental data, fundamentals of multi-criteria analysis. GIS based decision support system: fundamentals and applications.

Unit III: Interpolation and Digital Elevation Models

Sampling theory: Geographic data sampling methods Interpolation: Introduction, importance, data sources for interpolation, types of interpolation, Methods for interpolation (thesein polygons, inverse distance weighted, splines and krigging). Uses of interpolation, Issues involved with interpolation of spatial data. Surface mapping: Concept, types of surfaces and application. Digital Elevation Model (DEM): Definition, methods of development, and applications of DEM.

Books recommended:

Burrough, P. A. 1996. Principles of Geographic Information Systems for land resources assessment:. Oxford: Clarendon Press.

Introduction to GIS, Chang, K. 2004. 2nd Edition. McGraw-Hill, Dubuque, Iowa.

Clarke, K. C. 2003. Getting Started with Geographical Information Systems. 4th Edition. Prentice Hall, Upper Saddle River, New Jersey.

Lo, C. P. and Yeung, A. K. 2007. Concepts and techniques of geographic information systems, Pearson Prentice Hall.

DeMers, M.N. 2002. Fundamentals of Geographic Information Systems, 2nd Edition. John Wiley and Sons, New York.

GI17203CR : Practical-Advanced Geoinformatics

- Geospatial data editing, and attributes
- Use of Model Builder for Geospatial Analysis.
- Spatial data analysis
- Census and other socio-economic data analysis.
- Spatial modelling in GIS environment particularly land degradation, and hydrological
- Modelling.
- Individual/Group-wise assignment on spatial modeling

GI17204DCE: DBMS AND GEOSPATIAL DATABASES

Coarse goals

- To make an understanding about the working of database management system.
- To define queries in the standard language SQL, stored tables and queries.
- To learn about the aspects of data base design and its applications.

Unit I: Fundamentals of Database Management System
Database concepts. Steps in database design: Prototype model and Waterfall model. Database management system (DBMS): Network DBMS, Hierarchical DBMS, Relational DBMS, Codd's rules, Comparison between these DBMS. Editing and Storing GIS databases. Concept of keys in a database.

Unit II: DBMS Concepts
Theoretical and mathematical understanding of database querying: Relational Algebra. Basics of SQL, data types and constraints in SQL. Data definition language, data manipulation language, data control language in SQL. GIS Data modelling using Entity Relationship Diagrams. Framing the ER models for: Village Information system, Tourist Development Authority, Rural Development, Water Resource Information System.

Unit III: Regional and Global databases I
Global land use datasets. Global ecosystem maps. Datasets related to vegetation: Global forest datasets-AVHRR global forest resource assessment, AVHRR NDVI dataset, Hansen (2013) global forest change database. Global NPP datasets. BALANS land cover data Agriculture datasets-FAOSTAT and its components. Vegetation map of India (Champion and Seth 1968; Roy et al 2015). Harmonized world soil database.

Unit IV: Regional and Global databases II
Global topographic data: GOTOPO, SRTM, ASTER, Carto DEM. GEOnet names server, Gridded population of the world, Global glacier inventories: RGI, WGI, GLIMS. ICIMOD glacier inventory. World lake database. National Wetland Inventory Assessment. Wetland Atlas of Jammu and Kashmir. Web-portals for data download: Bhuvan, Earth Explorer, WebGIS, India-WRIS. Global climate datasets: ECOCLIMATE, WorldClim.

Books recommended:
Elmasri, R., Navathe S. B. 2007. Fundamentals of Database Systems, Pearson Education.
Benynon-Davies, P. 2002. An introduction to Informatics in Organizations. Information Systems: Palgrave (formally Macmillan).
Date, C. J. 2000. An introduction to Database Systems, Reading, M. A. Addison-esley.
Ramakrishnan, R. and Gehrke J. 2003. Database Management Systems, Boston, M. A, McGraw.
Teorey, T.J. 1994. Data base Model Design: The fundamental Principles, San Mateo, CA, Morgan Kaufmann.

GI17205DCE: DISASTER, RISK AND HAZARD ASSESSMENT

Coarse goals
- To learn about the application of geoinformatics for disaster management.
- To develop and devise logistic action plans for the post disasters with the help of GIS analysis.

Unit I: Principles of Disaster Management
Natural disasters (earthquakes, floods, landslides, GLOFS, avalanches), anthropogenic disasters; hazards, risks and vulnerabilities. Assessment of disaster vulnerability of a location and vulnerable groups. Preparedness and mitigation measures for various disasters. Disaster management with respect to earthquakes, flood and landslides

Unit II: Remote sensing for disaster management
Satellite remote sensing for disaster management, real time disaster analysis and management, identification of flood prone areas using remote sensing and other ancillary data, post disaster analysis of inundated areas, area estimations, crop loss estimates etc. Forest fire identification and zonation

Unit I: Fundamentals of Database Management System
Database concepts. Steps in database design: Prototype model and Waterfall model. Database management system (DBMS): Network DBMS, Hierarchical DBMS, Relational DBMS, Codd's rules, Comparison between these DBMS. Editing and Storing GIS databases. Concept of keys in a database.

Unit II: DBMS Concepts
Theoretical and mathematical understanding of database querying: Relational Algebra. Basics of SQL, data types and constraints in SQL. Data definition language, data manipulation language, data control language in SQL. GIS Data modelling using Entity Relationship Diagrams. Framing the ER models for: Village Information system, Tourist Development Authority, Rural Development, Water Resource Information System.

Unit III: Regional and Global databases I
Global land use datasets. Global ecosystem maps. Datasets related to vegetation: Global forest datasets-AVHRR global forest resource assessment, AVHRR NDVI dataset, Hansen (2013) global forest change database. Global NPP datasets. BALANS land cover data Agriculture datasets-FAOSTAT and its components. Vegetation map of India (Champion and Seth 1968; Roy et al 2015). Harmonized world soil database.

Unit IV: Regional and Global databases II
Global topographic data: GOTOPO, SRTM, ASTER, Carto DEM. GEOnet names server, Gridded population of the world, Global glacier inventories: RGI, WGI, GLIMS. ICIMOD glacier inventory. World lake database. National Wetland Inventory Assessment. Wetland Atlas of Jammu and Kashmir. Web-portals for data download: Bhuvan, Earth Explorer, WebGIS, India-WRIS. Global climate datasets: ECOCLIMATE, WorldClim.

Books recommended:
Elmasri, R., Navathe S. B. 2007. Fundamentals of Database Systems, Pearson Education.
Benynon-Davies, P. 2002. An introduction to Informatics in Organizations. Information Systems: Palgrave (formally Macmillan).
Date, C. J. 2000. An introduction to Database Systems, Reading, M. A. Addison-esley.
Ramakrishnan, R. and Gehrke J. 2003. Database Management Systems, Boston, M. A, McGraw.
Teorey, T.J. 1994. Data base Model Design: The fundamental Principles, San Mateo, CA, Morgan Kaufmann.

GI17205DCE: DISASTER, RISK AND HAZARD ASSESSMENT

Coarse goals
- To learn about the application of geoinformatics for disaster management.
- To develop and devise logistic action plans for the post disasters with the help of GIS analysis.

Unit I: Principles of Disaster Management
Natural disasters (earthquakes, floods, landslides, GLOFS, avalanches), anthropogenic disasters; hazards, risks and vulnerabilities. Assessment of disaster vulnerability of a location and vulnerable groups. Preparedness and mitigation measures for various disasters. Disaster management with respect to earthquakes, flood and landslides

Unit II: Remote sensing for disaster management
Satellite remote sensing for disaster management, real time disaster analysis and management, identification of flood prone areas using remote sensing and other ancillary data, post disaster analysis of inundated areas, area estimations, crop loss estimates etc. Forest fire identification and zonation

using remote sensing data. Seismic microzonation.

Unit III: Geoinformatics for disaster assessment: Flood control, drought management, cyclones, avalanches, land use planning. GPS for early warning system for disasters. GIS for Risk assessment, Recent trends in Geoinformatics for disaster management.

Books recommended:

Aki, K. and Richards P.G. 2002. Quantitative Seismology, University Science Books, S, C A.
Bolt, B.A. 1992. Inside the Earth, W.H. Freeman, SanFrancisco.
Alcira K., Margaret A., Anee C. 2003. Building safer cities, NYork UN. Press.
Pascale Zarate 2008. Collaborative Decision Making: Perspectives and Challenges, James and James Science Publisher.
Fowler, C.M.R. 1990.The Solid Earth: An Introduction to Global Geophysics, C. Press.
Demer, Michael, N. 2000. Fundamentals of Geographic Information Systems: John Wiley and Sons, Inc.
Iyer, H.M. and Hirahara K. (Eds.) 1993. Seismic Tomography Theory and Practice, C and H, NY.
Kyoji S., Paolo C. 2008. Landslides-Risk reduction, Kluwer Academic Publishers. Lay, T. and T.C. Wallace 1995. Modern Global Seismology, Academic Press, San Diego.
Eve C., Denis S., Steve T. 2000, Risk management and Society

GI17206DCE: MAPPING FROM SPACE

Individual/Group assignment on mapping and analysis of infrastructure / natural resources / utilities using satellite data and GIS to train the student on digitial mapping using GIS/RS. The students shall be exposed to the field validation / ground truth of the generated maps and post-field correction of the maps using various indices / matrices.

GI17207DCE: REMOTE SENSING FOR URBAN AND REGIONAL PLANNING

Coarse goals

- To use different high-resolution satellite data products for urban planning.
- To develop a credible remote sensing and GIS system for urban area related problems.

Unit I: Introduction to Urban Planning

Principles of urban area development and land use planning. Importance of Urban and regional planning. Urbanization trends in Jammu and Kashmir with special reference to the Srinagar and Jammu city centres. Impact of urbanization on different natural resources of Jammu and Kashmir with reference to some case studies. Master planning for urban land use. Unplanned urbanization and resource mis-management.

Unit II: Remote Sensing for Human Settlement Analysis

Urban area identification and interpretation using high and moderate resolution remote sensing data, Various classification systems; Residential area classification; Space use classification system; Urban land use classification systems, interpretation, monitoring and change detection analysis using satellite imagery. Mapping urban land use and urban sprawl with remotely sensed data.

Unit III: Socio-economic GIS

Census operation in India, census data and field observations, Demographic and social patterns, Socio economic and residential area evaluation. Remote sensing for population studies and settlement, slum settlement detection. Updating of population data, Traffic and parking survey with high spatial resolution satellite data, Role of Geoinformatics in Transportation Planning. Geoinformatics for cadastral based land information system.

using remote sensing data. Seismic microzonation.

Unit III: Geoinformatics for disaster assessment: Flood control, drought management, cyclones, avalanches, land use planning. GPS for early warning system for disasters. GIS for Risk assessment, Recent trends in Geoinformatics for disaster management.

Books recommended:

Aki, K. and Richards P.G. 2002. Quantitative Seismology, University Science Books, S, C A.
Bolt, B.A. 1992. Inside the Earth, W.H. Freeman, SanFrancisco.
Alcira K., Margaret A., Anee C. 2003. Building safer cities, NYork UN. Press.
Pascale Zarate 2008. Collaborative Decision Making: Perspectives and Challenges, James and James Science Publisher.
Fowler, C.M.R. 1990.The Solid Earth: An Introduction to Global Geophysics, C. Press.
Demer, Michael, N. 2000. Fundamentals of Geographic Information Systems: John Wiley and Sons, Inc.
Iyer, H.M. and Hirahara K. (Eds.) 1993. Seismic Tomography Theory and Practice, C and H, NY.
Kyoji S., Paolo C. 2008. Landslides-Risk reduction, Kluwer Academic Publishers. Lay, T. and T.C. Wallace 1995. Modern Global Seismology, Academic Press, San Diego.
Eve C., Denis S., Steve T. 2000, Risk management and Society

GI17206DCE: MAPPING FROM SPACE

Individual/Group assignment on mapping and analysis of infrastructure / natural resources / utilities using satellite data and GIS to train the student on digitial mapping using GIS/RS. The students shall be exposed to the field validation / ground truth of the generated maps and post-field correction of the maps using various indices / matrices.

GI17207DCE: REMOTE SENSING FOR URBAN AND REGIONAL PLANNING

Coarse goals

- To use different high-resolution satellite data products for urban planning.
- To develop a credible remote sensing and GIS system for urban area related problems.

Unit I: Introduction to Urban Planning

Principles of urban area development and land use planning. Importance of Urban and regional planning. Urbanization trends in Jammu and Kashmir with special reference to the Srinagar and Jammu city centres. Impact of urbanization on different natural resources of Jammu and Kashmir with reference to some case studies. Master planning for urban land use. Unplanned urbanization and resource mis-management.

Unit II: Remote Sensing for Human Settlement Analysis

Urban area identification and interpretation using high and moderate resolution remote sensing data, Various classification systems; Residential area classification; Space use classification system; Urban land use classification systems, interpretation, monitoring and change detection analysis using satellite imagery. Mapping urban land use and urban sprawl with remotely sensed data.

Unit III: Socio-economic GIS

Census operation in India, census data and field observations, Demographic and social patterns, Socio economic and residential area evaluation. Remote sensing for population studies and settlement, slum settlement detection. Updating of population data, Traffic and parking survey with high spatial resolution satellite data, Role of Geoinformatics in Transportation Planning. Geoinformatics for cadastral based land information system.

Unit IV: GIS for Urban Resources and Services Planning
Eco-zonation of ecologically fragile landscapes. Urban facility mapping, Advancement of Geoinformatics in services sector particularly Utilities. Urban land evaluation and suitability analysis, Urban hazards and risk management. Seismic micro zonation of urbanized areas.

Books recommended:
Hashim, N. and Rainis, R. 2003. Urban Ecosystem Studies in Malaysia: A Study of Change. Universal-Publishers.
Branch, M. C. 1971. City Planning and Aerial Information. Cambridge, Harvard Uni. Press.
Burrough, P.A. 1996. Principles of Geographic Information Systems for land resources assessment: Oxford: Clarendon Press.
Demer, Michael, N. 2000. Fundamentals of Geographic Information Systems, John Wiley and Sons, Inc.

GI17208GE: APPLICATIONS OF REMOTE SENSING

Unit I: Mapping using Remote Sensing Data
NNRMS Mapping standards for land use land cover and urban land use. Introduction to Land use and Land cover mapping. Sensor characteristics: Low, medium and high resolution satellite datasets and their mapping applications.

Unit II: Applications of Remote Sensing
Flood inundation mapping using satellite data. Identifying landslide prone sites using remote sensing data. Vegetation mapping using remote sensing. Application of remote sensing in quantifying urbanization.

Books recommended:
Lillesand, R.M. and Kiefer R.W. 1994. Remote Sensing and Image Interpretation, NY: John Wiley and Sons, Inc.
Jensen, J.R., 1996. Introductory Digital Image Processing, A Remote Sensing Perspective, Upper Sanddle River, Prentice Hall.
Cracknell, A.P and L.W.B. Hayes, 1993. Introduction to Remote Sensing, Taylor and Francis London.

GI17209GE: OCEANOGRAPHY

Unit I: Oceanography
Ocean circulation: Horizontal circulation, vertical circulation. Circulation in different Oceans. Coastal erosion and Wave study. Changing levels of the Shoreline. Ocean circulation and climate change

Unit II: Waves
Characteristics, Wind-generated waves, Tsunami, Internal waves. Tides: Characteristics and origin, Tidal currents, Tides as a source of power.

Books recommended:
Kennett, J. P. 1982. Marine Geology. Prentice Hall.
Pinet, P. R. 1992. Oceanography, An Introduction to the Planet Oceanus. West Pub. Co.
Seibold, E. and Berger, W. H. 1982. The Sea Floor. Springer-Verlag.
Smoot, N. C., Choi, D. R and Bhat, M. I. 2002. Marine Geomorphology. XLIBRIS Corp.
Smoot, N. C., Choi, D. R. and Bhat, M. I. 2002. Active Margin Geomorphology. XLIBRIS Corporation Thurman, H. B. 1978. Introductory, Oceanography. Charles, E. Merrill Pub. Co.

Unit IV: GIS for Urban Resources and Services Planning
Eco-zonation of ecologically fragile landscapes. Urban facility mapping, Advancement of Geoinformatics in services sector particularly Utilities. Urban land evaluation and suitability analysis, Urban hazards and risk management. Seismic micro zonation of urbanized areas.

Books recommended:
Hashim, N. and Rainis, R. 2003. Urban Ecosystem Studies in Malaysia: A Study of Change. Universal-Publishers.
Branch, M. C. 1971. City Planning and Aerial Information. Cambridge, Harvard Uni. Press.
Burrough, P.A. 1996. Principles of Geographic Information Systems for land resources assessment: Oxford: Clarendon Press.
Demer, Michael, N. 2000. Fundamentals of Geographic Information Systems, John Wiley and Sons, Inc.

GI17208GE: APPLICATIONS OF REMOTE SENSING

Unit I: Mapping using Remote Sensing Data
NNRMS Mapping standards for land use land cover and urban land use. Introduction to Land use and Land cover mapping. Sensor characteristics: Low, medium and high resolution satellite datasets and their mapping applications.

Unit II: Applications of Remote Sensing
Flood inundation mapping using satellite data. Identifying landslide prone sites using remote sensing data. Vegetation mapping using remote sensing. Application of remote sensing in quantifying urbanization.

Books recommended:
Lillesand, R.M. and Kiefer R.W. 1994. Remote Sensing and Image Interpretation, NY: John Wiley and Sons, Inc.
Jensen, J.R., 1996. Introductory Digital Image Processing, A Remote Sensing Perspective, Upper Sanddle River, Prentice Hall.
Cracknell, A.P and L.W.B. Hayes, 1993. Introduction to Remote Sensing, Taylor and Francis London.

GI17209GE: OCEANOGRAPHY

Unit I: Oceanography
Ocean circulation: Horizontal circulation, vertical circulation. Circulation in different Oceans. Coastal erosion and Wave study. Changing levels of the Shoreline. Ocean circulation and climate change

Unit II: Waves
Characteristics, Wind-generated waves, Tsunami, Internal waves. Tides: Characteristics and origin, Tidal currents, Tides as a source of power.

Books recommended:
Kennett, J. P. 1982. Marine Geology. Prentice Hall.
Pinet, P. R. 1992. Oceanography, An Introduction to the Planet Oceanus. West Pub. Co.
Seibold, E. and Berger, W. H. 1982. The Sea Floor. Springer-Verlag.
Smoot, N. C., Choi, D. R and Bhat, M. I. 2002. Marine Geomorphology. XLIBRIS Corp.
Smoot, N. C., Choi, D. R. and Bhat, M. I. 2002. Active Margin Geomorphology. XLIBRIS Corporation Thurman, H. B. 1978. Introductory, Oceanography. Charles, E. Merrill Pub. Co.

Unit-I: Earth System System concept for earth system science. Components of the geosphere and environment - lithosphere, biosphere, hydrosphere and atmosphere, Hydrologic cycle, Energy balance.

Unit-II: Relationships between the major subsystems
Biogeochemical cycles - nitrogen cycle, carbon cycle and phosphorous cycle. Long-term evolution of earth system. Quaternary environmental changes, Atmosphere-ocean interactions, El Niño-Southern Oscillation, evidence for global warming, Paleoclimate proxies.

Books recommended:

Gass I.G. et al 1982: Understanding the Earth. Artemis Press (Pvt.) Ltd. U.K.
Windley B. 1973: The Evolving continents. John Wiley & Sons, New York.
Condie, Kent. C. 1982. Plate Tectonics and Crystal Evolution Pergamon Press Inc.
Gansser, A.Geology Of Himlayas, Cox , Plate Tectonicsa and Geotectonic reversal, Heim and Gansser, Central Himalaya,
Sinha, A. K., Sassi, F. P. and Papinikolaou, D., 1997. Geodynamic domains in the Alpine- Himalayan Tethys,
Sharma, K. K., 1991. Geology and Geodynamic evolution of the Himalayan CollissionZone.Thakur, V. C. and Sharma, K. K., 1983.Geology of the Indus Suture Zone of Ladakh.

GI17307GE: MAPPING IN GIS

Course Goals:

- To make students familiar with earth observation data analysis.
- To help students in accessing globally available geospatial data repositories
- To expose students to basics of mapping using GIS platforms.

Unit-I: Fundamentals of mapping
National Mapping standards - NNRMS and its importance.Levels of classification from earth observation data.NNRMS standards from land cover and vegetation mapping.Basic components of a map and concept of scale in mapping. Data sources for mapping: remote sensing, field observations, GPS, maps and other ancillary data. Hands-on GIS: Creation of point, line and polygon theme).

Unit-II: Basics of Geospatial Analysis
Elements of image interpretation. Web-portals for data download: Bhuvan and Earth Explorer. Delineating land use land cover from earth observation data: Opportunities and challenges. Ground truth procedure and ground data collection pertaining to land cover and vegetation. Hands-on GIS: Land cover mapping, Map making and Accuracy assessment.

Books recommended

Burrough, P. A. 1996. Principles of Geographic Information Systems for land resources assessment, Oxford: Clarendon Press.
De Mers, M. N. 2002. Fundamentals of Geographic Information Systems. John Wiley and Sons, New York.
Ormeling, F., &Kraak, M. J. 2010. Cartography: Visualization of Geospatial Data. Prentice Hall.
Robinson, Arthur H., JoelL. Morrison, Phillip C. Muehrcke, A. Jon Kimerling, and Stephen C. Guptill 1995.Elements of Cartography, John Wiley and Sons, New York.

GL17308GE: FRONTIERS IN EARTH SCIENCES

Coarse goals:

- Students will be able to understand the language of geology
- Students will learn knowledge of geologic information

Unit-I
Introduction: Origin of Earth, Structure of earth; Crust, Mantle & Core;
Outer spheres: Atmosphere, hydrosphere, biosphere of the earth, Exogenous and endogenous process.

Unit-II
Biogeochemical cycles - nitrogen cycle, carbon cycle and phosphorous cycle.
Geological Time Scale: Lithostartigraphic Units, Chronostratigraphic Unit and Biostratigraphic Unit
Geology as the history of Earth: (a) Fossils (b) Mineralogy and the texture; (c) Structures; (d) Palaeogeography (e) Paleoclimate.

Books recommended
Holmes, A., 1996: Principles of Physical Geology, EUBS, Chapman.
Judson, S. and Kaufman, M. E., 1990: Physical Geology, Prentice Hall.
Press, F. and Seiver, R., 1989: The Earth, W. H. Freeman

GL17309OE: LAND RESOURCES OF KASHMIR

Coarse goals

- To make students familiar with the mineral resources present in their own state.

Unit-I
Renewable resources: Definition. Soil: definition, classification, formation and soil types of Kashmir. Economic mineral resources: Origin of petroleum. Reservoir and source rocks – definition and types.

Unit-II
Coal: definition, formation and classification of coal. Petroleum prospecting in Kashmir.Ore minerals and gangue.Mineral deposit of Jammu and Kashmir.Distribution and uses of Marble, Granite, Basalt, Limestone and Slate in Kashmir.

Books Recommended
Bamzai, P. N. K (1994),Culture And Political History Of Kashmir (3 Vols. Set), M.D. Publications,ISBN97881-85880-31-0.
Sir Walter Roper Lawrence (1895).The Valley of Kashmir.Asian Educational Services, 1895.
Raina A. N. (2002) Geography of Jammu & Kashmir State .RadhaKrishanAnand& Co.
Qazi S.A. (2005).Systematic Geography Of Jammu And Kashmir. APH Publishing, 2005.
Evan, A. M., 1983: Ore Geology and industrial Minerals. Blackwell.
Holson, G. D. and Tiratsoo, E. N., 1985: Introduction Petroleum Geology. Gulf Pub. Houston,
Jensen, M. L. and Bateman, A. M., 1981: Economic Mineral Deposits, John Wiley.
Keller, S. E., 1994: Mineral Resources, Economic and the Environment. McMillan College Pub.
Levarson, 1985: Geology of Petroleum. CBS Pub.
Prasad, U., 1996: Economic Geology. CBS Pub. N. Delhi

Lo, C. P. & Yeung, A. K. 2007. Concepts and techniques of geographic information systems, Pearson Prentice Hall.
Laurini, R and Thompson, D. 1992. Fundamentals of spatial information systems, Academic Press London.

GI17107GE: INTRODUCTION TO REMOTE SENSING

Unit I: Overview of Remote Sensing
Electromagnetic radiation (EMR) and Electromagnetic Spectrum (EMS). Interactions of EMR with earth's surface features; vegetation, water, and soils. Remote sensing: Definition, history and scope. Overview of a typical remote sensing system and its components.

Unit II: Sensors and Satellite systems
Sensor resolution (Spatial, spectral, temporal) and its importance. Characteristics of important satellite systems: LANDSAT and IRS. Applications of satellite data in earth observation. Elements of image interpretation. Hands on satellite data.

Books recommended:
Lillesand, T., Kiefer, R. W. & Chipman, J. 2014. Remote sensing and image interpretation. John Wiley & Sons.
Emilio C. 2016. Fundamentals of Satellite Remote Sensing: An Environmental Approach, CRC Press
Jensen, J. R. 1996. Introductory digital image processing: a remote sensing perspective (No. Ed. 2). Prentice-Hall Inc.
Qihao W. 2017. Advances in Environmental Remote Sensing, CRC Press.
Principles of remote sensing. A handbook from ITC Netherlands.
Available at: http://www.itc.nl/library/papers_2009/general/PrinciplesRemoteSensing.pdf

GI17108GE: GIS Basics

Unit I: Fundamentals of GIS
Overview of GIS: GIS basics: Introduction, Definition, historical perspective, Components of GIS, types of GIS. Concept of data, examples of GIS; Geospatial data sources (Remote Sensing, GPS, Maps and Field observations).

Unit II: Geospatial data analysis
Spatial and non-spatial data: introduction, importance and integration. Data models: Raster and Vector data models. Hands on GIS software: Creation of vector data (point, line and polygon).

Books recommended:
Chang, K. 2004. Introduction to GIS, McGraw-Hill, Dubuque, Iowa.
Lo, C. P. & Yeung, A. K. 2007. Concepts and techniques of geographic information systems, Pearson Prentice Hall.
De Mers, M.N. 2002. Fundamentals of Geographic Information Systems. John Wiley.
Tasha Wade (Ed). 2006. A to Z GIS: An Illustrated Dictionary of Geographic Information Systems. Shelly Sommer (Ed), ESRI, USA.
Heywood I, Sarah C and Steve C. 2011. An Introduction to Geographical Information Systems. Prentice Hall.

GI17109OE: CLIMATOLOGY

Unit I: Climate System of Earth
Components of the climate system, climate forcing, Climate system response, -response rates and interactions within the climate system. Incoming solar radiation, receipt and storage of heat, heat

Unit IV: GIS for Urban Resources and Services Planning
Eco-zonation of ecologically fragile landscapes. Urban facility mapping, Advancement of Geoinformatics in services sector particularly Utilities. Urban land evaluation and suitability analysis, Urban hazards and risk management. Seismic micro zonation of urbanized areas.

Books recommended:
Hashim, N. and Rainis, R. 2003. Urban Ecosystem Studies in Malaysia: A Study of Change. Universal-Publishers.
Branch, M. C. 1971. City Planning and Aerial Information. Cambridge, Harvard Uni. Press.
Burrough, P.A. 1996. Principles of Geographic Information Systems for land resources assessment: Oxford: Clarendon Press.
Demer, Michael, N. 2000. Fundamentals of Geographic Information Systems, John Wiley and Sons, Inc.

GI17208GE: APPLICATIONS OF REMOTE SENSING

Unit I: Mapping using Remote Sensing Data
NNRMS Mapping standards for land use land cover and urban land use. Introduction to Land use and Land cover mapping. Sensor characteristics: Low, medium and high resolution satellite datasets and their mapping applications.

Unit II: Applications of Remote Sensing
Flood inundation mapping using satellite data. Identifying landslide prone sites using remote sensing data. Vegetation mapping using remote sensing. Application of remote sensing in quantifying urbanization.

Books recommended:
Lillesand, R.M. and Kiefer R.W. 1994. Remote Sensing and Image Interpretation, NY: John Wiley and Sons, Inc.
Jensen, J.R., 1996. Introductory Digital Image Processing, A Remote Sensing Perspective, Upper Sanddle River, Prentice Hall.
Cracknell, A.P and L.W.B. Hayes, 1993. Introduction to Remote Sensing, Taylor and Francis London.

GI17209GE: OCEANOGRAPHY

Unit I: Oceanography
Ocean circulation: Horizontal circulation, vertical circulation. Circulation in different Oceans. Coastal erosion and Wave study. Changing levels of the Shoreline. Ocean circulation and climate change

Unit II: Waves
Characteristics, Wind-generated waves, Tsunami, Internal waves. Tides: Characteristics and origin, Tidal currents, Tides as a source of power.

Books recommended:
Kennett, J. P. 1982. Marine Geology. Prentice Hall.
Pinet, P. R. 1992. Oceanography, An Introduction to the Planet Oceanus. West Pub. Co.
Seibold, E. and Berger, W. H. 1982. The Sea Floor. Springer-Verlag.
Smoot, N. C., Choi, D. R and Bhat, M. I. 2002. Marine Geomorphology. XLIBRIS Corp.
Smoot, N. C., Choi, D. R. and Bhat, M. I. 2002. Active Margin Geomorphology. XLIBRIS Corporation Thurman, H. B. 1978. Introductory, Oceanography. Charles, E. Merrill Pub. Co.

transformation, earth's heat budget. Layering of Atmosphere, Atmospheric circulation. Heat transfer in ocean. Conveyor belt and its control on earth's climate.

Unit II: Climate Change
Natural and Anthropogenic impacts of climate change. Response of cryosphere to earth's climate. Brief introduction to archives of climate change. Milankovitch cycles. Glacial interglacial stages. The Last Glacial maximum (LGM), Younger Dryas and LIA.

Books recommended:
Ahren, C.D., 2012: Meteorology Today, 10th edition, Cengage Learning.
Anthes, R. 1997: Meteorology, 7th edition, Prentice-Hall Inc., Upper Saddle River.
Barry, R.G. & Chorley, R.T. 1992: Atmosphere, Weather & Climate, 6th edition, Routledge, London.

GL17110OE: Rocks and Minerals

Unit I: Petrology
Rocks: Definition, Types. Description of common rock types: Basalt, Granite, Sandstone, Limestone, Shale, Conglomerate, Marble, Slate, Schist, Gneiss. Rock types of Kashmir

Unit II: Mineralogy
Minerals: Definition and Types, Physical and chemical properties. Mineral resources of Kashmir

Books recommended:
Holmes, A. 1996. Principles of Physical Geology, EUBS, Chapman.
Judson, S. and Kaufman, M. E. 1990. Physical Geology, Prentice Hall.
Press, F. and Seiver, R. 1989. The Earth,
Terrly, G. W. 1958. Principles of Petrology.
Gribble, D. D. 1988. Rutley's Elements of Mineralogy, DBS Publications.
Tarbuck, E. J. and Lutgens, F. K. 1997, Earth Science, Prentice Hall.
Lutgens, F. K. and Tarbuck, E. J. 1998. Essentials of Geology, Prentice Hall.

Unit IV: GIS for Urban Resources and Services Planning
Eco-zonation of ecologically fragile landscapes. Urban facility mapping, Advancement of Geoinformatics in services sector particularly Utilities. Urban land evaluation and suitability analysis, Urban hazards and risk management. Seismic micro zonation of urbanized areas.

Books recommended:
Hashim, N. and Rainis, R. 2003. Urban Ecosystem Studies in Malaysia: A Study of Change. Universal-Publishers.
Branch, M. C. 1971. City Planning and Aerial Information. Cambridge, Harvard Uni. Press.
Burrough, P.A. 1996. Principles of Geographic Information Systems for land resources assessment: Oxford: Clarendon Press.
Demer, Michael, N. 2000. Fundamentals of Geographic Information Systems, John Wiley and Sons, Inc.

GI17208GE: APPLICATIONS OF REMOTE SENSING

Unit I: Mapping using Remote Sensing Data
NNRMS Mapping standards for land use land cover and urban land use. Introduction to Land use and Land cover mapping. Sensor characteristics: Low, medium and high resolution satellite datasets and their mapping applications.

Unit II: Applications of Remote Sensing
Flood inundation mapping using satellite data. Identifying landslide prone sites using remote sensing data. Vegetation mapping using remote sensing. Application of remote sensing in quantifying urbanization.

Books recommended:
Lillesand, R.M. and Kiefer R.W. 1994. Remote Sensing and Image Interpretation, NY: John Wiley and Sons, Inc.
Jensen, J.R., 1996. Introductory Digital Image Processing, A Remote Sensing Perspective, Upper Sanddle River, Prentice Hall.
Cracknell, A.P and L.W.B. Hayes, 1993. Introduction to Remote Sensing, Taylor and Francis London.

GI17209GE: OCEANOGRAPHY

Unit I: Oceanography
Ocean circulation: Horizontal circulation, vertical circulation. Circulation in different Oceans. Coastal erosion and Wave study. Changing levels of the Shoreline. Ocean circulation and climate change

Unit II: Waves
Characteristics, Wind-generated waves, Tsunami, Internal waves. Tides: Characteristics and origin, Tidal currents, Tides as a source of power.

Books recommended:
Kennett, J. P. 1982. Marine Geology. Prentice Hall.
Pinet, P. R. 1992. Oceanography, An Introduction to the Planet Oceanus. West Pub. Co.
Seibold, E. and Berger, W. H. 1982. The Sea Floor. Springer-Verlag.
Smoot, N. C., Choi, D. R and Bhat, M. I. 2002. Marine Geomorphology. XLIBRIS Corp.
Smoot, N. C., Choi, D. R. and Bhat, M. I. 2002. Active Margin Geomorphology. XLIBRIS Corporation Thurman, H. B. 1978. Introductory, Oceanography. Charles, E. Merrill Pub. Co.

Choice based Credit System (CBCS) Scheme and course structure for M.Sc. Geoinformatics
3rd semester effective from academic session 2017 and onwards

3rd SEMESTER

Course Code	Course Name	Paper Category	Hours per week			Credits
			L	T	P	
GI17301CR	Field Survey and GNSS	Core	3	0	0	3+0+0=3
GIP17301CR	Practical- Field Survey and GPS	Core	0	0	1	0+0+1=1
GI17302CR	Advanced GIS Data Analysis and modelling	Core	3	0	0	3+0+0=3
GIP17302CR	Practical-Advanced GIS Data Analysis and modelling	Core	0	0	1	0+0+1=1
GI17303CR	Hydroinformatics	Core	3	1	0	3+1+0=4
GI17304DCE	Term Work (compulsory)*	Elective (DCE)	3	0	0	3+0+0=3
GI17305DCE	Glaciology	Elective (DCE)	3	0	0	3+0+0=3
GI17306DCE	Earth System Science	Elective (DCE)	2	0	0	2+0+0=2
GI17307GE	Mapping in GIS	Elective (GE)	2	0	0	2+0+0=2
GL17308GE	Frontiers in Earth Sciences	Elective (GE)	2	0	0	2+0+0=2
GL17309OE	Land Resources of Kashmir	Open Elective(OE)	2	0	0	2+0+0=2
GL17310OE	Water Resources of Kashmir	Open Elective(OE)	2	0	0	2+0+0=2
24 credits			25	1	2	28
L= Lecture; T= Tutorial; P= Practical						

GI17301 CR: FIELD SURVEYAND GNSS

Course goals

- To make students understand the importance of fieldwork and enable them to collect field data on various aspects of earth system.
- To acquire the skills of interpreting, synthesizing and disseminating field data and information.
- To make use of data derived from the field into a GIS.

Unit I: **Introduction to Surveying and Mapping**: Geographic data collection, spatial location and reference. Issues and challenges in geospatial data collection from remote sensing platforms and ground based approach. Historical background in the advancements in surveying. Basic principles of surveying, Type of surveys, (a) Surveying techniques, (b) Procedure of field survey, (c) Collection of data, (d) Error adjustments. Ground truth data format for land cover, wetlands, forests, urban built up and glaciers. NNRMS mapping standards.

Unit II: Digital Field Data Capture Techniques: Traditional Field Equipment: - Theodolite, Abney Level, Plane Table. Application of latest technology instruments like GPS, 3D Laser Scanners, EDM,

Total Station for field mapping. Compilation of data: Data quality assessment, Digitizing and the creation of a geospatial database. Data interpretation by integration of field and remotely sensed data.

Unit III: Global Navigation Satellite Systems: Geo-positioning basic concepts. Introduction to GNSS, concept, types and components. Concepts of DGPS, GNSS satellite constellations: Russian, European, GAGAN, IRNSS. GPS accuracy, wave frequencies, error corrections. Ground data collection: spatial and non-spatial data for analysis and modelling, GPS signal interferences, Applications of GPS in resources surveys / mapping, crustal deformation and urban land cover.

GIP17301CR: Practical Field Survey and GPS

- GPS handling and ground data collection through LDM, Camera, measuring tape, etc.
- Accuracy assessment of the satellite based land use and land cover data.
- GPS survey of the University Campus, Dal Lake and Mughal gardens/ public parks.
- Validation of the satellite-based Digital Elevation Models with the GPS data.
- 2 weeks field visit for mapping glaciated terrain, city/town, and tourist resort, whichever feasible.
- Group assignment on any of the above field based observations.

References:

GPS Satellite Surveying, Leick A (1995): 2nd end. Wiley, New yorkChicheste Brisbane Toronto Singapore.

GPS Theory and Practice, Hofmann-Wellenhof B, Lichtenegger H: (2007). Springer (5th eds), Wien New York.

Global Positioning System and GIS, An Introduction, Kennedy, M. Ann Arbor,MI,1996.

Concepts and techniques of Geographic Information System : Lo C.P: Albert. Prentice Hall. Remote Sensing and Image Interpretation, Lillesand, R. M. and R. W. Kiefer, 1994, 3rd Ed. NY: John Wiley and Sons, Inc

GI17302CR: ADVANCED GIS - DATA ANALYSIS AND MODELLING

Coarse goals

- Utilize spatial models to make simulations and predictions of real life phenomena.
- Evaluate models in terms of accuracy, sensitivity, and uncertainty.
- Use a system-based approach for problem solving.

Unit I: Modelling concepts: Modelling frameworks and approaches; Types and classification of models.Distributed andlumped models, empirical models, semi-empirical models, deduction and induction models.Raster based modelling (Map algebra) and surface modelling (hydrological modelling Cellular Automata (Agent modelling)Hypothesis testing vs. exploratory data analysis

Unit II: Model Evaluation: Frameworks for selecting the "best model", Model validation: Sensitivity Analysis, Uncertainty Analysis, Resiliency Statistical measures of agreement. Model calibration. Data quality issues with observational data. Statistical measures of agreement. Importance of observation networks to understand and predict land surface and climate processes.

Unit III: Modelling Approaches: Geospatial model Input parameters w.r.t. Hydrological, Erosion and Nutrient models. Remote sensed hydro-meteorological parameters and their uses in modelling. Downscaling and up scaling of geospatial data. Statistical approaches of representing natural variations.

GIP17302CR:**Practical Advanced GIS - Data Analysis and Modelling**

- Floodplain and flood inundation mapping using earth observation and GPS data Basics of nutrient load modelling-Pload model
- Assessing the discharge and sedimentyeild using geospatial modelling environment-SheTran
- Image indices-NDVI and NDSI on Landsat data
- Structure of village level socioeconomic data from Census of India and basic data analysis
- Hands on multi-criteria analysis

4TH SEMESTER

Course Code	Course Name	Paper Category	Hours per week			Credits
			L	T	P	
GI17401CR	**Project work**	Core	0	12	0	0+6+0=6
GI17402CR	**Geospatial Statistics**	Core	3	0	0	3+0+0=3
GIP17402CR	**Practical Geospatial Statistics**	Core	0	0	1	0+0+1=1
GI17403CR	**Open Sources GIS**	Core	0	0	2	2+0+0=2
GI17404DCE	**Geomorphology from Space**	Elective (DCE)	2	0	0	2+0+0=2
GI17405DCE	**Climatology and Climate Change**	Elective (DCE)	3	0	0	3+0+0=3
GI17406DCE	**Advance Remote Sensing and GIS**	Elective (DCE)	3	0	0	3+0+0=3
GL17411 GE	**Fundamentals of Geotectonics**	Elective (GE)	2	0	0	2+0+0=2
GL17412 GE	**Natural Disasters**	Elective (GE)	2	0	0	2+0+0=2
GL17413 OE	**Earth Surface Processes**	Elective (OE)	1	2	0	1+1+0=2
GL17414 OE	**Water Quality**	Elective (OE)	1	2	0	1+1+0=2
24 credits			21	12	1	28
L= Lecture; T= Tutorial; P= Practical						

GI17401CR: PROJECT WORK

As a part of the curriculum, the students would be assigned research/project work related to the use of remote sensing and Geographic Information System for any of the themes/areas on landuse/landcover mapping, cartography, geomorphology, civil engineering, hydrology, agriculture, urban and regional planning, database development, assessment of earth resources and other general environmental problems. The objective is to expose students to various techniques so that they would consolidate their skills learned in the theory and practical sessions of related to various courses.

GI17402CR: GEOSPATIAL STATISTICS

Coarse goals

- To understand the concept and techniques of Geospatial statistics.
- To apply the Geospatial techniques on spatial varying phenomena.

Unit I: Fundamentals of Geospatial Statistics: Introduction: importance and application of Statistics for Earth Sciences. Spatial sampling procedures, non- sampling and sampling errors, sampling design. Design of experiments. Confidence intervals.Hypothesis testing.Analysis of variance.The statistical methodology and models to analyse time series data with special reference to geological, environmental and agriculture sciences.Models and methods for the analysis of dataset with missing values.

Unit II: Techniques and Applications of Geospatial Statistics: Overview of applications and techniques for univariate and multivariate statistics for multi- dimensional satellite data; spatial continuity analysis; estimation; simulation. Overview of spatial statistics, estimation, and modelling with examples.Autocorrelation principles.Variogram analysis. Applications of variogram analysis for continuously varying phenomena like soil moisture, forest structure

Unit III: Statistical Analysis: Descriptive statistics and data analysis, organizing, summarizing and analyzing spatial data, histogram analysis, probability distribution, scatter plots and data redundant analysis for multi-dimensional spatial data, correlation in multivariate data, data transformations (logarithmic, indicator, normal-score, rank-order); principal component analysis. Time series analysis and applications of time series analysis for feature extract from the multi-temporal satellite data, remote sensing applications like soil moisture, vegetation analysis and disaster management

GIP17402CR: Practical Geospatial statistics

- R statistical software Basics
- Basic statistical analysis using available statistical data analysis packages
- Hands on exercise on plotting and graphic software

References

Kitanidis (1997).Introduction to Geostatistics.University Press.

Cressie (1993).Statistics for Spatial Data.Wiley& Sons.

Gelfand, Diggle, Fuentes, Guttorp (2010). The Handbook of Spatial Statistics.Chapman& Hall/CRC.

David, M., Hand book of Applied Advanced Geostatistical Ore Reserve Estimation,Elsevier,Amsterdam,216pp.,1988.

Gelfand, A.E., Diggle, P.J., Fuentes, M., and Guttorp, P., eds. (2010) Handbook of Spatial Statistics, CRC Press.

Hald,A. Statistical Tables and Formulas, Wiely, New York,1952.

Isaaks, E.H. and R.M. Srivastava (1989) An Introduction to Applied Geostatistics. Oxford University Press. (QE33.2 .M3 I83 1989)

James E. Burt and Gerald M. Barber, 1996, Elementary Statistics for Geographers, 2nd ed., Guilford Press.

Metheron,G., Principals of geostatistics, Economic Geology,58,1246-66,1963

Stewart Fotheringham and Peter A. Rogerson (eds.), 2009, The SAGE Handbook of Spatial Analysis, SAGE Publications.

Warrick, A.W.,D. E. Myers and D. R. Nielsen, Geostatistical methods applied to soil sciences, in Methods of Soil Analysis,Part1,Agronomy monogram No.9, American society for Agronomy,Madison,Wis.,1986

GI17403CR: OPEN SOURCES GIS

Course Goals:

- To expose students to free open source platforms for remote sensing and GIS data analysis
- Develop competence among students in the use of geospatial tools available from open source GIS platforms.

Unit I: Geospatial Analysis in QGIS:

QGIS features; menu and toolbars; Map navigation. Vector Analysis: Digitization and Symbology, Geoprocessing-Buffer, Union, Intersect, Clip, Data Import/Export and Querying, On the fly projection. Raster data analysis: Virtual raster, Mosiacing, Terrain analysis, zonal statistics, Projections and transformations. Open street maps. Plugins in QGIS. Map Composition in QGIS.

Unit II: Fundamentals of ILWIS:

Key features of ILWIS. Displaying geographic data in ILWIS, Displaying raster and vector data in ILWIS, Concept of domains in ILWIS. Coordinate systems and georeferencing in ILWIS. Raster and vector data import. Rasterization and vectorization.Resampling, Subset, Resampling and band

visualization.

References:

Anita Graser. (2016). Learning QGIS - Third Edition. Packt Publishing, Birmingham UK.
Kurt Menke, Richard Smith Jr., Luigi Pirelli, John Van Hoesen. (2015). Mastering QGIS - Second Edition. Packt Publishing, Birmingham UK.
Jesse Russell, Ronald Cohn. (2012). ILWIS.Book on Demand, Berlin Germany.

GI17404DCE: GEOMORPHOLOGY FROM SPACE

Coarse goal

- To understand the dominant process shaping a particular landscape.
- To be able to identify landforms using the remote sensing technology.

Unit I:**Fluvial Landforms:** Introduction to Fluvial landforms; Types; Drainage Systems; Drainage Basins; Drainage Patterns; Flood Plains and Terraces; Paleochannels.

Unit II: Landform Mapping: Introduction to Landform mapping. Geomorphological mapping theory and development and diversity.Introduction to Geomorphic Mapping; Role of Remote Sensing in mapping, Geomorphic mapping analysis.

References

Nicholas M. Short, Sr. and Robert W. Blair 1986: Geomorphology from Space is an out of print 1986 NASA publication.
Bloom, A. L., 2002: Geomorphology, A Systematic Analysis of L. Cenozoic Land Forms. Prentice Hall Pvt. Ltd., N. Delhi.
Burbank, D. W. and Anderson, R.S., 2001: Tectonic Geomorphology Blackwell Sciences
Easterbrook, Easterbrook, 1994: Surface Processes and Land Forms. Prentice Hall.
McCalpin, J., 1996: Paleoseismology Academic Press.
Pitty, A. F, 1982: Nature of Geo-Morphology. University Paper Backs. Ritter, D. F., 1978: Process Geomorphology. Wm. C. Brown Publishers, Lowa Sharma, V. K., 1986: Geomorphology. Tata McGraw Hill. Thorrenberry, W. D., 1997: Principles of Geomorphology New Age International, Delhi.
Vishwas, S. K and Gupta, A., 2001: Introduction to Geomorphology Orient Longman

GI17405DCE: CLIMATOLOGY ANDCLIMATE CHANGE

Coarse goal

- To give a basic understanding of climate and its variables.
- To understand the process of climate change and its impacts.

Unit I: Atmospheric Layers and Thermal Variation: Nature, composition and layered structure of the atmosphere. Factors controlling insolation; heat budget of the atmosphere.Horizontal and vertical distribution of temperature; Inversion of temperature.Green house effect and importance of ozone layer.

Unit 11 Atmospheric Layers and Wind Circulation: Global atmospheric pressure belts and their oscillation. General wind circulation.Jet stream and index cycle.Monsoon mechanism with reference to jet stream.General.Synoptic weather forecasting, prediction of weather elements such as rain.maximum and minimum temperature and fog; hazardous weather elements like thunderstorms, Dust storms.

Unit I: Concepts and Overview of Remote Sensing
Remote sensing: Definition, history and scope. Overview of remote sensing systems: Typical Remote Sensing system and its components, sensor resolution (Spatial, spectral, temporal and radiometric), important satellite systems; LANDSAT, SPOT, IRS, MODIS, IKONOS, ASTER. Electromagnetic radiation (EMR) and Electromagnetic Spectrum (EMS): parts of electromagnetic radiation, theories of electromagnetic radiation, radiation laws, atmospheric windows. Interactions of EMR with atmosphere, interaction of EMR with earth's surface features; vegetation, water, and soils. Spectral signatures of common land-cover types and criterion of choosing signatures.

Unit II: Satellite Data Interpretation
Types of Sensors: OM Line scanners, CCD Line and Area scanners. Photo-grammetry: types and characteristics of aerial photographs (scale, resolution, projection, overlaps), measurement of scale and height, relief displacement, stereoscopy. Stereo-imaging: principles, and sensors for stereo-imaging (ASTER). Principles of visual image interpretation: elements of visual image interpretation, importance and factors governing the interpretability. Use of ancillary information for satellite data interpretation. Ground Truth Collection: importance, methods, and Ground truth details.

Unit III: Digital Image Processing
Digital Image processing (DIP): Introduction to DIP. Digital data and storage formats (BSQ, BIL, BIP, GeoTIFF and HDF). Image statistics, particularly histogram and scatterplots. Geometric and Radiometric distortions. Pre-processing of satellite data (radiometric and geometric corrections), Color composites: band combination, false color composite and true color composites. Image enhancements: linear, non-linear, and histogram equalization.

Books recommended:
Lillesand, T., Kiefer, R. W., & Chipman, J. 2014. Remote sensing and image interpretation. John Wiley & Sons.
Jensen, J. R. 1996. Introductory digital image processing: a remote sensing perspectiv*e* (No. Ed. 2). Prentice-Hall Inc.
Cracknell, A. P and Hayes, L.W.B. 1993. Introduction to Remote Sensing, Taylor and Francis London.
Colwell, R. N. 1983. Manual of remote sensing. American Society of Photogrammetry.
Jensen, John R. 2004. Introductory Digital Image Processing, Prentice Hall

GIP17102CR: Practical-Fundamentals of Remote Sensing
- Tutorial on different modules of image processing software.
- Different image and remote sensing data formats
- Utility of image statistics in image interpretation
- Visual interpretation of different earth features from the images
- Spectral response of different earth features from multi-spectral image data
- Preparation of satellite data for analysis like rotate, subset, layer stacking.
- Pre-processing of satellite data like haze reduction, image registration and geo-correction.
- Image processing operations like, image enhancements and math operations.

GI17103CR: FUNDAMENTALS OF GEOGRAPHIC INFORMATION SYSTEM

Course Goals
- Impart the basic knowledge of the principle concepts of geo-spatial data handling with GIS
- Develop competence in the use of geospatial tools for, analysis and use of thematic, spatial and spatiotemporal data.

Unit I: Overview of GIS
GIS basics: Introduction, Definition, historical perspective, Components of GIS. Types of GIS.

Concept of data, examples of GIS; Geographic data sources (Remote Sensing, GPS, Maps and Field observations). Spatial and non-spatial data: introduction, importance and integration.

Unit II: Databases and Data Models
Data models: Concept and types, Raster data model, Vector data model, Advantages and disadvantages of raster and vector data models, issue related to data model conversation. Data errors, data editing. Concept and applications of Topology in GIS.

Unit III: Geospatial Data Analysis
Geospatial analysis: Introduction, vector-based analysis (Non- topological and topological functions with examples of each type), Raster based analysis (Local operations, neighbourhood operations, extended neighbourhood operations, regional operations with examples of each type).

Books recommended:
Burrough, P. A. 1996. Principles of Geographic Information Systems for land resources assessment, Oxford: Clarendon Press.
Demer, Michael, N. 2000. Fundamentals of Geographic Information Systems, JW and Sons.
Chang, K. 2004. Introduction to GIS, McGraw-Hill, Dubuque, Iowa.
Clarke, K. C. 2003. Getting Started with Geographical Information Systems, Prentice Hall, Upper Saddle River, New Jersey.
De Mers, M. N. 2002. Fundamentals of Geographic Information Systems**.** John Wiley and Sons, New York.
Chrisman, N. 2002. Exploring Geographic Information Systems**,** J W and Sons

GIP17103CR: Practical-Geospatial analysis

- Familiarization with GIS software systems
- Data input; digitization, scanning
- Data editing of spatial and non-spatial data
- Use of attributes and other tabular data
- Database creation, linking, joining and registration
- Geo-processing of geospatial data like buffering, proximity analysis etc.
- Data query and preliminary data analysis
- Map making and production

GI17104DCE: CARTOGRAPHY AND GEOINFORMATION VISUALIZATION

Course Goals
- Expose students to the basic and advanced techniques of digital cartography for visual exploration and presentation of the geo-information data.
- Develop map design, composition and editing skills
- Teach techniques for Integration of thematic, spatial and non-spatial data at various scales

Unit I: Map Making
Maps: Introduction, types of maps, uses of maps. Cartography: analogue and digital cartography, cartographic generalizations. Map composition: map design and layout, map scale, legend, annotations. Coordinate systems, Geoid, shape of earth and datums, Map projections: introduction, properties and aspects of map projections, classification of map projections.

Unit II: Data Sources and Visualization
Data sources for mapping: remote sensing, field observations, GPS, maps and other ancillary data.

GI17202CR: ADVANCED REMOTE SENSING AND IMAGE PROCESSING

Course Goals

- Develop skills for advanced remote sensing and image processing of satellite data.
- Impart know-how on the methods of extracting information from the satellite data.
- Demonstrate the usefulness of satellite data for real world applications

Unit I: Advanced Remote Sensing Systems

Remote sensing in 21st century. Extra-terrestrial/Planetary Remote Sensing, Geophysical Remote Sensing and its applications. Thermal remote sensing: introduction and applications. Hyper spectral remote sensing: introduction and applications. Concepts of LiDAR. Integration of multi-sensor data: introduction, technique, constraints and applications.

Unit II: Image Processing Techniques

Uni-variate and multi-variate statistics in Digital Image Processing. Filtering: introduction, high pass filter, low pass filters, density slicing, edge enhancement and detection filters. Band math and ratioing: image indices (VI, NDVI, PVI, SAVI). Principal component analysis (PCA): introduction, technique and applications.

Unit III: Classification of Satellite Data

Image classification: Supervised and Unsupervised approaches, Parametric and Non-parametric classifiers, Per-and Sub-pixel Classification, Stages of supervised classification. Feature selection and feature reduction. Classification algorithms: ISODATA, K-means, Maximum likelihood, Mean distance to means, Parallelepiped, Mahalanobis. Limitations of statistical classifiers. Advanced image classification techniques: Knowledge based classifier, Artifical Neural Networks and Fuzzy c-means clustering. Classification Accuracy Assessment: testing samples, error matrix, errors of commission and omissions, Kappa statistics.

Books recommended:

Gupta, R. P. 2003. Remote Sensing Geology, Springer-Verlag

Rencz, A. N. 1999. Manual of Remote Sensing for Earth Sciences, J W and Sons.

Richards, J.A. and Jia, X. 2005. RS Digital Image Analysis: An Introduction, Springer Verlag

Lillesand, R.M. and R.W. Kiefer, 1994. Remote Sensing and Image Interpretation, *3rd Ed*, NY: John Wiley and Sons, Inc.

Sabins, F. F., Freeman W. H. 1987. Remote sensing principles and interpretation, Taylor & Francis San Francisco.

Campbell, J.B 2011. Introduction to remote sensing, Taylor and Francis, London.

John A. Richards 1993. Remote Sensing Digital Image Analysis, Springer-Verlag.

J.R. Jensen 1996. Introductory Digital Image Processing, A Remote Sensing Perspective, , Upper Sanddle River, Prentice Hall.

GIP17202CR: Practical-Advanced Remote Sensing and Image Processing

- Advanced image processing techniques viz., Principle component analysis of remote sensing data
- Mosaicing of images, Image Fusion
- Digital Image Classification: Unsupervised and Supervised, Change Detection Analysis
- Accuracy assessment of thematic maps
- Microwave data processing and Quantification of backscattering from different features
- Development of spectral indices using optical remote sensing data
- Individual/Group-wise assignment