**Skill Enhancement Courses Earth Sciences (Geology and Geoinformatics)**

<table>
<thead>
<tr>
<th>Name of the Course</th>
<th>Course Code</th>
<th>Name of the Programme</th>
<th>Year of introduction</th>
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</thead>
<tbody>
<tr>
<td>Economic and Petroleum</td>
<td>GL15106DCE and GL15107DCE</td>
<td>MSc Applied Geology</td>
<td>2001</td>
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<tr>
<td>Engineering Geology</td>
<td>GL15205DCE</td>
<td>MSc Applied Geology</td>
<td>2011</td>
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<tr>
<td>Disaster, Hazard and Risk Assessment</td>
<td>GL15206DCE/GL15205DCE</td>
<td>MSc Applied Geology &amp; MSc Geoinformatics</td>
<td>2015</td>
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<td>Geophysical exploration</td>
<td>GL15207DCE</td>
<td>MSc Applied Geology</td>
<td>2012</td>
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<tr>
<td>Mining and Exploration geology</td>
<td>GL15402DCE</td>
<td>MSc Applied Geology</td>
<td>2012</td>
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<tr>
<td>Hydrogeology</td>
<td>GL15302CR</td>
<td>MSc Applied Geology</td>
<td>2011</td>
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<tr>
<td>Hydro informatics</td>
<td>GI15306CR</td>
<td>MSc Geoinformatics</td>
<td>2015</td>
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<td>Natural resource management</td>
<td>GI15306DCE</td>
<td>MSc Geoinformatics</td>
<td>2015</td>
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<td>RS in Geosciences</td>
<td>GI15303DCE</td>
<td>MSc Geoinformatics</td>
<td>2015</td>
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<tr>
<td>Application of RS and GIS</td>
<td>GI15105DCE</td>
<td>MSc Geoinformatics</td>
<td>2015</td>
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<tr>
<td>Cartography and geoinformation visualisation</td>
<td>GI15104DCE</td>
<td>MSc Geoinformatics</td>
<td>2015</td>
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<tr>
<td>Remote sensing for urban and regional planning</td>
<td>GI15206DCE</td>
<td>MSc Geoinformatics</td>
<td>2012</td>
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<tr>
<td>Surveying techniques</td>
<td>GI15106DCE</td>
<td>MSc Geoinformatics</td>
<td>2015</td>
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<tr>
<td>Field surveying and GPS</td>
<td>GI15301CR</td>
<td>MSc Geoinformatics</td>
<td>2012</td>
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<td>Open source GIS</td>
<td>GI15403DCE</td>
<td>MSc Geoinformatics</td>
<td>2015</td>
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<tr>
<td>Database management system</td>
<td>GI15207DCE</td>
<td>MSc Geoinformatics</td>
<td>2015</td>
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<tr>
<td>Computers and geoinformation management and Applications of Geoinformatics</td>
<td>GI15101CR and GI15209GE</td>
<td>MSc Geoinformatics</td>
<td>2015</td>
</tr>
</tbody>
</table>

**Syllabus**

**GL17106DCE: Economic Geology**

**Unit-I**


Fluid inclusions: types, assumptions, techniques and limitations.

**Unit-II**

Fuel Geology: Coal: origin and classification of coal. Macroscopic and microscopic constituents of coal. Geological and geographical distribution of coal deposits in India with emphasis on Gondwana coal fields of India.

**Books recommended**
GL17107DCE: Petroleum Exploration

Unit-I
Source rocks, reservoir rocks and different types of traps. Amount, type and maturation of organic matter. Petroleum and source rock correlation. Locating petroleum prospects based on principles of petroleum generation and migration (geological modeling).

Geophysical methods of Hydrocarbon exploration.

Unit-II
Petroleum basins: Basin studies and basin analysis. Basin classification in plate tectonics. Fundamental types of petroliferous basin; relation between basin type and hydrocarbon richness. Factors favoring hydrocarbon abundance. Petroleum provinces of India and world
Case studies of some giant oil fields

Unit-III
Elements of well drilling: Cable-tool drilling, rotary drilling, various types of drilling units. Elements of logging. Electric, radioactive and sonic logs. Nuclear magnetic resonance and dielectric logging Application of logs in petro-physical analysis and facies analysis

Books recommended

GL17205DCE: Engineering Geology

Unit-I

Unit-II
Geological considerations for construction of dams, reservoirs, and tunnels. Tunnel alignment and transportation routes. Methods of tunneling and various types of tunnel support. Geological consideration for construction of roads, buildings and bridges.

Unit-III
Mass movements with special emphasis on landslides and slope stability. Earthquakes and seismic zones of India. Case history of engineering projects and geological causes for failures of engineering structures and remedial measures.

Books recommended:
Bell, F. G., Engineering Properties of Soils and Rocks.
Bryant, E., 1985: Natural Hazards. Cambridge University Press.
Goodman, R. E., Engineering Geology.

GL17206DCE: Disaster, Risk & Hazard Assessment

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:
Natural Hazards and Human-Exacerbated disasters, Edgardo Latrubesse. National University of Colombia. Risk management and Society-Eve Coles, Denis Smith, Steve Tombs, 2000

GL17207DCE: Geophysical Exploration
Unit-I
General and Exploration geophysics- Different types of geophysical methods; Gravity, magnetic, Electrical, Seismic, radioactive- their principles and applications. Concepts and Usage of corrections in geophysical data. Role of geophysical data in explaining geodynamical features of the earth.

Unit-I
Geophysical field operations: Different types of surveys, grid and route surveys, profiling and sounding techniques, scales of survey, presentation of geophysical data. Application of Geophysical methods - Regional geophysics, oil and gas geophysics, ore geophysics, groundwater geophysics, engineering geophysics.

Unit-III
Geophysical anomalies: Correction to measured quantities, geophysical, anomaly, regional and residual (local) anomalies, factors controlling anomaly, depth of exploration. Integrated geophysical methods - Ambiguities in geophysical interpretation, Planning and execution of geophysical surveys.

Books recommended:
GL17402CR: Mining & Exploration Geology

UNIT I
Classification of mining methods, introductory geological and economic aspects of mine planning, developmental works for underground mining, mode of entry in mines, drift, crosscuts, winz, raise, ore bin and ore chuites. Surface mining methods; placer mining methods and open pit methods, ground sluicing, hydraulic mining, dredging, drift mining, shovel mining and multi bench, lateral advance mining method, their advantages and disadvantages. Underground mining methods; open stopes mining methods, supported stopes mining methods, shrinkage, cut and fill and square set mining methods, caving methods- top slicing sublevel caving and block caving, their advantages and disadvantages.

UNIT II
Mining supports; support types with their merits and demerits. Stowing methods; subsidence -causes and prevention. Methods of breaking and blasting the rocks, types of explosives used; arrangements of drill holes for blasting in surface and underground mines. Mining atmosphere; ventilation in underground mines, types and arrangements of directing ventilations in underground mining.

UNIT III

Books recommended:
Stach,
GL17302CR: Hydrogeology

Theory

Unit-I

Unit-II
Groundwater development: Groundwater exploration methods – geological & geophysical (resistivity, magnetic and seismic) methods. Borehole geophysical logging – electrical, resistivity and SP; Radiation logging – gamma, gamma-gamma, and neutron logging. Cliper and temperature logging. Preparation of strata charts, design of tube well assembly and water well design criteria. Water level development and yield tests, well completion reports. Groundwater modeling techniques, data requirement.

Unit-III

GLP17302CR: Practical Hydrogeology

Books recommended:
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 the identification and management of potential ground water resources.


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.


References
Coarse goals
To acquaint the students with the applications and use of Geoinformatics for Natural Resource Conservation and Management.
To impart knowledge about the GIS analytical capabilities to solve environmental Problem.
To equip the students with the know-how about integrated environmental analysis using Geoinformatics.

Fundamentals of Natural Resource Management:

Climate Change: Process and Consequences:

Remote Sensing of Natural Resources:
exploration and distinction. Water resources (snow and glaciers): inventorying, change detection studies and glacier retreat.

**GIS for Natural Resource Management:**

**References:**
DS Lal. Climatology. Sharda Pustak Bhawan

**GL17303CR: Remote Sensing in Geosciences**

**Theory**

**Unit-I**
Remote sensing: basic concepts, fundamentals, data sources, Types of scanners and image acquisition: History and scope of remote sensing, concepts of remote sensing, electromagnetic radiations, matter interactions with atmosphere and terrain atmospheric windows, spectral reflectance of vegetation, soils, minerals and rocks. Elements of visual image interpretation. Factors governing image interpretation, verification and validation of RS data (Ground Truthing).

**Unit-II**

**Unit-III**
GLP17303CR: Practical Remote Sensing in Geosciences
Remote Sensing in Geosciences: Tutorial on different modules of image processing software; Import and export of satellite data; Different image and remote sensing data formats; Familiarization with the earth surface features on the images; Preparation of satellite data for analysis like rotate, reflect, subset, layer addition; Pre-processing of satellite data like image registration, geo-correction, filtering, image enhancements, math operations; Image ratios and other remote sensing and geological indices like SAVI; Lithologic, land use/land cover feature identification Familiarization with GIS software systems.

Books recommended:

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

Unit III: Remote Sensing Applications

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:

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

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**

**Unit IV: Data Presentation**

**Books recommended:**

**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


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:


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:
Laurini, R and Thompson, D. 1992. Fundamentals of spatial information systems,
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.


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:


**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, Mosaiccing, 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:**


**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


Unit II: DBMS Concepts


Unit III: Regional and Global databases I


Unit IV: Regional and Global databases II


Books recommended:


GI17101CR: COMPUTERS AND GEOINFORMATION MANAGEMENT

Course Goals

- Develop basic skills and understanding of the computer operations.
- Development of basic computer programming skills.
- Geospatial data handling and management.

Unit I: Programming and Problem Solving in C
Introduction to number systems and conversions. Basic flowcharts with examples. ‘C’ character set, keywords, data types, constants, variables, Operators: arithmetic, logical, relational, assignment and conditional operators. Expressions and statements in C, Symbolic constants. Basic programs in C. Control statements: If statements, If-Else and Switch-Case statement with examples. Loops in C: While, Do-While and For Loop with examples. Introduction to: Arrays, Structures, Functions and Pointers.

Unit II: Geospatial Data Handling

Unit III: Geospatial Data Management

Books recommended:


Current review and comparisons of different hardware and software published frequently, particularly for the DOS environment in magazines such as Byte and PC Magazine.

GIP17101CR: PRACTICAL-GEOSPATIAL DATA HANDLING AND MANAGEMENT

- Computers: Handling and maintenance
- Hands on MS Office (MS Word, MS Excel, MS Power point)
- Control statements: If, If-Else and Switch-statements.
- Loops: While, Do-While and For Loops,
- Data conversions: Basic import and export operations in GIS
- Data management schemes/methods in GIS