MERCURY

Geographic Information Systems (GIS)

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Introduction:

Knowledge of Geographic Information Systems GIS is an increasingly sought after skill in industries from agriculture to public health. This Specialization, offered in partnership with ArcGIS developer Esri, will teach the skills you need to successfully use GIS software in a professional setting. You will learn how to analyze your spatial data, use cartography techniques to communicate your results in maps, and collaborate with peers in GIS and GIS-dependent fields. In the final Capstone Project, you will create a professional-quality GIS portfolio piece using a combination of data identification and collection, analytical map development, and spatial analysis techniques

Targeted Groups:

- Engineers
- Architects
- Contractors
- Anyone who has a desire to explore the application of GIS in their fields

Course Objectives:

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

- Explain what a GIS is and what it can do
- Create GIS maps in ArcMap
- Access and query a GIS database using ArcMap
- Display map data using symbology and labels
- Describe two common GIS data formats
- Perform simple GIS Analysis

Targeted Competencies:

- Cartographic principles.
- Experience realistic tasks in the context of international case studies.
- Wildlife conservation and leisure hiking to archaeology and disaster relief.
- Creating maps
- GIS spatial elements
- Some basic topological relationships
- The DIME topological structure
- Data normalization
- Digital image analysis
- Surveying and mapping

Course Content:

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Unit 1: Introduction to GIS:

- Information systems
- Management Information system MIS - Decision Support System DSS - Expert Systems
- Integrated Information System. Data, Information, Knowledge.
- Geographic information and GIS

Unit 2: What is GIS:

- Some GIS definitions. Other Terms Used for GIS.
- Database management system graphic & non-graphic data,
- Software for manipulating, displaying & plotting data,
- Algorithms and techniques for spatial analysis.

Unit 3: Components of GIS:

- Hardware
- Central processing unit CPU, Auxiliary storage units, Input-output units
- Software
- Main package Arc/InfoESRI, Microstation, Application package
- Data
- “spatial” or “geographic”?
- Accuracy, Precision, Time, Currency, Completeness.
- Data organization,
- Decision Model.
- Valid Criteria.
- Georeferenced Data.
- Data Layers.
- User People

Unit 4: Data Processing Steps:

- Data input and conversion, Data management
- Data processing
- Data analysis and modeling
- Data output

Unit 5: Regular Tasks Accomplished in a GIS:

- Display on the screen
- Edit, change, transform
- Measure distances, areas
- Combine maps of the same area

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Unit 6: What is GIS Used For?

- Municipal Spatial Data
- Basemaps / topographic maps
- Cadastral maps lot boundaries, parcel boundaries, easement and right-of-way
- Urban planning maps
- AM/FM Data sewer system, water system, electricity, communication
- Street network Data road centerlines, intersections, lights, trees,...
- Area Data demographic, tax rate, school district, emergency response,...
- Environmental Data soil map, flood plain maps, noise level map, streams, water bodies, parks,...

Unit 7: GIS Applications:

- Problem types
- Location: What is at?
- Condition: Where is it?
- Trend: What has changed since?
- Routing: What is the best way?
- Pattern: What special patterns exist?
- Model: What if...
- GIS is based on knowledge from :
- Remote Sensing, Geodesy, Photogrammetry, Surveying, Cartography, Computer science, Mathematics, Statistics
- Disciplines using GIS
- Geodesy and Geomatics, Civil Eng., Geology ...Early Applications of GIS
- Current GIS applications
- Business
- Census, elections
- Surveying and mapping
- Map and database publishing
- Public health and safety hospital, police, fire...
- Real estate information management
- Municipal Applications infrastructure,...
- Engineering Applications
- Forest Development and Management/Erosion and deforestation
- Agriculture and land use, harvest prognoses
- Environmental applications vegetation, pollution, ...
- Hydrology, water pollution drainage patterns, water catchment, ...
- Geology DTM, fault-line detection, mineral detection
- Transportation, vehicle tracking, navigation systems,...

Unit 8: Advantages of GIS:

- Large data volumes, make costs drop, improved accuracy, and precision...
- GIS costs
- Capital
- Operating costs

Unit 9: CAD/CAM Systems, History of GIS? GIS Information Sources:

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- Books, magazines and journals, conferences:
- Data Input into GIS
- The importance of Data
- GIS maps are digital, not analog
- Real and Virtual maps
- GIS Data Conversion
- Traditionally most of the cost of a GIS project
- Data collection is time-consuming and expensive but one time cost
- Captured from analog maps by GEOCODING
- Digitizing : manual digitizer, automated photogrammetry, stereoplooter
- Scanning image size & resolution, vectorizing
- Field data collection remote sensing To be reformulated
- Remote sensing data acquisition steps
- Electromagnetic radiation spectrum
- Passive & active remote sensing
- Sensor platforms, satellite orbits, swaths
- Spatial and temporal resolution slide 55
- Land Observation Satellites and Sensors slide 56
- Digital image analysis
- Pre-processing:
- Geometric Restoration rectification,geocoding?
- Radiometric Restoration
- Display and Enhancement
- B&W and color-composite display
- Zoom-in, zoom-out
- Contrast manipulation
- Image algebra
- Spatial filtering
- Principle Component analysis
- Texture analysis
- Digital Elevation Models DEM etc.
- Information Extraction
- Classification Supervised classification, Unsupervised?
- Radar image processing analysis
- Hyperspectral data analysis
- Digital photogrammetry to extract DEM and orthophotographs
- Geographic Information systems GIS?
- Raster based GIS
- Vector-based GIS
- Image and Cartographic Map Composition
- Integrated Image Analysis and GIS
- Alternative data entry methods
- GPS
- Surveying
- Existing digital data
- Attribute Data
- Table with rows and columns
- Editing and Validation
- Data are incomplete or double
- Data in the wrong place or digitized incorrectly
- Data at the wrong scale
- Data are distorted

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Unit 10: Coordinate Systems:

- Definition of the map.
- Topographic, thematic, line, photo maps
- Understanding Maps
- Scale
- Contour interval
- Map projection and datum
- Map accuracy
- General questions answered using maps
- Traditional uses: Navigation land, sea, air?, Engineering, urban, regional, national planning, Infrastructure planning and design, Terrain analysis, National defense
- Plane Coordinate Systems
- Cartesian, polar coordinates. Their interconversion.
- Three Dimensional Systems
- Earth Coordinate Geometry
- Rotation of the earth, equator,
- Parallels, meridians, degrees/minutes/seconds,
- Great and small circles,
- Reference ellipsoid, geodetic datum, WGS94,
- Earth models: Flat, Spherical, Ellipsoid, Geoid
- Global coordinate systems
- Datums: local, regional, global. Shifts, conversions.
- Datums used in turkey
- Geodetic latitude, longitude, and height

Unit 11: Map Projections:

- Definition: Map Projection
- Types of Map Projections
- Conformal Orthomorphic projections
- Equal area Homolographic projections
- Equidistance projections
- Equidirection projections
- Cylindrical, azimuthal, conical projections
- Aspect of map projections: normal, transverse, oblique
- Properties of the projections used in Turkey
- Lambert Conical Projection:
- Mercator’s Projection conformal
- Universal Transverse Mercator Projection UTM
- K.Eren/Joe-Tek Lambert Conical Projection
- Transformation of the Map Projections
- Analytical Methods
- Polynomial Transformation
- Direct grid-on-grid transformation
- Selecting a suitable map projection
- Criteria influencing the selection of a map projection
- Some general rules tropical areas: cylindrical etc
- Young's rule

Unit 12: Database Management:

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- Data management concepts
- First, second, third generation data management
- DBMS, components, advantages, disadvantages
- Components of a DBMS
- Data schema. Type, attributes, relationships.
- Formal schema, table-based schema, flat-file database
- Database instance vs database schema.
- Database design stages: conceptual, logical, and physical design.
- DBMS main components: Data definition language, Data dictionary, Data-entry module, Data update module, Report generator, Query language
- Data models: hierarchical, network, relational. Relations one-to-many etc
- Relational database management systems RDBMS
- Common key attribute
- Procedural and non-procedural query languages
- Retrieval operations sort, renumber, subset, search
- GIS as a user interface to the database
- Spatial retrieval operations
- Concepts of domain, atomic values, keys
- Data normalization
- Data structures.
- Spatial data structures key, entity, classification code, feature code, topological relationships, data source
- Spatial features size, distribution, pattern, contiguity, neighborhood, shape, scale, orientation
- GIS analysis on spatial data
- Points symbol operations
- Line symbol operations

Unit 13: Spatial Data Models:

- GIS spatial elements
- Coverages, tiles,
- Value, shape, Location, Spatial reference
- Vector versus raster
- Conversions between vector and raster
- Raster data model
- Value, shape, location, grid structure
- Mixed pixel
- Data compression
- Quad-tree structure
- Vector data model
- Points, lines and polygons
- Spaghetti data model
- Topology connectivity, orientation, adjacency, containment
- Nodes, arcs and polygons
- Topology
- Some basic topological relationships
- The DIME topological structure
- The POLYVRT topological structure
- Arc topology
- Relational spatial join
- Topology building, network building, polygon building
- Topological overlay
- Common errors in spatial data

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- Vectors and 3-D
- Triangulated Irregular Network TIN
- Delaunay triangulation
- Spatial data formats
- Common data formats
- TIGER/LINE data format
- Standards for format conversion
- The Open GIS Consortium OGC
- Spatial data on the internet