CBEPS CCEAG

Canadian Board of Examiners for Professional Surveyors

Conseil canadien des examinateurs pour les arpenteurs-géomètres

S6 – Geospatial Information Systems

Content

- This document is a high-level curriculum design which captures the key principles, competencies, learning outcomes and syllabus items proposed for the updated curriculum specific to S6 – “Geospatial Information Systems”.

S6: GEOSPATIAL INFORMATION SYSTEMS

LEARNING OBJECTIVES

- **Establish the fundamental GIS knowledge required for decision making as a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies/Learning Outcomes
FUNDAMENTALS OF GIS	Surveyors need to understand the geospatial perspective of the project/work they do and the use of GIS for their projects	• History, evolution and components of GIS • Definition of and terminologies related to GIS • Relation to other types of information systems • Nature of geospatial data • Geographic representation and data models (vector and raster data) • Spatial referencing systems • Map projections • Base maps and map layers in GIS environment	**Competencies** • Describe the concepts, principles, techniques, and applications that are fundamental to GIS • Discuss how geospatial information systems differ from other information systems, technologies, and sciences **Learning Outcomes** • Interpret requirements for GIS, data layers, base maps and explain the role of standardized data in geospatial information system development to support decision making for survey projects

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DATA VISUALIZATION AND MAP MAKING	Surveyors need to visually represent data collected from the field by creating colourful maps for clients and stakeholders	• Essentials of map design • Essentials of graphic communication • Cartographic principles • Cartographic elements • Visual variables • Map symbology • Map types • Map scale and generalization • Canadian spatial reference and map projection systems	**Competencies** • Discuss appropriate map design, elements, symbology • Explain spatial referencing systems to visualize spatial data • Sketch thematic maps and general reference maps • Practice measurement scales and their relationships to visual variables **Learning Outcomes** • Apply GIS software tools to create maps and visualizations that are fit-for-purpose and effectively convey the information they are intended to • Compare and organise data from multiple heterogeneous sources • Compare and analyse graphics (e.g., maps and other forms of geographic visualizations) to explain, interpret, and assess information

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SPATIAL DATABASES and MODELS	Important for surveyors to understand how and where spatial data is being stored and queried, as spatial databases are at the core of a GIS	• Concepts of spatial databases • Types of spatial database models • Concepts of database modeling • Concepts of Extract, Transform and Load (ETL) Processes • Data query and SQL • Concepts of data structures, spatial and aspatial Indexes • Applications of spatial databases in data warehousing	**Competencies** • Describe and explain spatial data type and data warehouse and use appropriate spatial data types and spatial data warehouse • Demonstrate spatial data integration • Demonstrate how databases are linked to GIS following either relational database model (e.g., traditional geo-relational model) or object-relational database model and design database queries. • Compare the GIS data modeling process by identifying and explaining the different levels of data abstraction (conceptual, logical, and physical), data models and their features **Learning Outcomes** • Design and evaluate geospatial data using DBMS with geospatial capabilities • Implement the concept of spatial data extraction, transformation, and load (ETL) • Analyse SQL-based GIS queries and formulate ETL scripts/processes

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DATA ACQUISITION & MANIPULATION	Quality data needs to be acquired and manipulated to fit the purpose of survey projects	• Data acquisition • Data precision and accuracy • Data editing tools and techniques • Data conversion tools and techniques • Linear reference systems and dynamic segmentation • Topological relationships and handling • Metadata and data standards	**Competencies** • Describe considerations for acquisition of quality field data • Recognize and apply data editing and conversion techniques and data interpolation techniques • Illustrate role of standards in data sharing • Compare relevance and impact of data quality assessment **Learning Outcomes** • Implement different GIS data acquisition approaches and data sources that require the knowledge of data quality, data fusion, data exchange, metadata management, and other issues such as data pricing, data access policies, privacy, security, and organizational influences. • Examine and experiment appropriate tools and techniques to acquire and maintain high quality data and practice and apply appropriate data interpolation techniques

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GEOSPATIAL DATA ANALYSIS and ANALYTICAL MODELING	Data analysis and spatial modeling are critical for decision making	• GIS queries • Vector data analysis • Raster data analysis • Geoprocessing tools and techniques • Network analysis • Basic spatial statistical measures and analysis techniques • Types of spatial models • Analytical modeling • Big data analytics, non-structured data and NoSQL • Geospatial data mining methods • Dynamic geospatial data modeling • AI and deep learning	**Competencies** • Illustrate spatial thinking skills • Practice the specific problem solving and compare appropriate GIS analysis and modeling techniques to solve a specific problem • Operate GIS software tools to conduct spatial analysis **Learning Outcomes** • Demonstrate appropriate spatial analysis methods to support decision making • Experiment GIS analytical techniques and modeling to solve real-world spatial problems • Prepare data analysis and analytical modeling

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Digital Elevation Modeling (DEM)	DEM is widely used to model and represent the 3rd dimension of the earth's surface	• Concepts, modeling, methods and techniques and data sources • Implementation and applications of digital terrain modeling (DTM) in geomatics • Mathematical approaches and techniques for terrain surface reconstruction, terrain analysis, structure, storage, processing and applications of DTM • Generation of elevation Grid from a set of elevation points • Generation of triangular irregular networks (TIN), Delauney triangulation and Voronoi diagrams • Generation of contour lines from TIN and elevation Grids • Global and local deterministic interpolation methods from point data; Kriging geo-statistical interpolation • DEM acquisition methods • Accuracy and quality control, terrain parameters, visualization and generalization, applications	**Competencies** • Describe the various data models used for DEM • Describe and discuss the various parameters for terrain analysis • Demonstrate and apply appropriate terrain surface interpolations • Demonstrate and implement various terrain related applications such as visualization, hydrology, and earthworks ones • Illustrate DEM concepts and principles and the terrain surface representation. **Learning Outcomes** • Interpret mathematical approaches and techniques for terrain surface interpolations and reconstruction. • Examine and interpret terrain/surface parameters, visualization, generalization, accuracy, and quality control • Compare and analyse data acquisition methods for DEM applications. • Design and evaluate DTM applications and terrain analysis.

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BUILDING INFORMATION MODELING (BIM)	BIM and GIS integration provide surveyors with enhanced digital surveying tools	• Concepts of BIM • BIM model progression and specifications • BIM standardization • BIM implementation procedures and tools • BIM and GIS integration	**Competencies** • Identify and recognize advantages and limitations of BIM for surveying projects and geospatial applications • Recognize and review the process of BIM and GIS integration • Describe concept of BIM • Demonstrate the understanding of BIM/GIS integration **Learning Outcomes** • Illustrate and demonstrate need for BIM and GIS integration based on project requirements

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WEB/CLOUD GIS AND MAPPING	WebGIS is empowering surveyors to access and upload live data in user friendly environment and enabling stakeholder participation in the decision-making process	• Concepts of Web/cloud and mobile GIS • Concepts and types of Web mapping services • Sources of on-line geospatial data and web mapping services • Mobile data collection tools • Applications of Web/cloud and mobile GIS (e.g., SDI) • Data catalogue services • Technical, organizational, social issues and policies and standards related to web and mobile GIS • Open Geospatial Consortium	**Competencies** • Identify and review, different types of web/cloud GIS and mapping • Recognize necessity of traditional desktop GIS in line with recent development of web/cloud GIS and mapping • Describe the new developments regarding web/cloud GIS and mapping services for better geospatial information dissemination, decision support and applications **Learning Outcomes** • Demonstrate and practice the use of desktop, web/cloud, and mobile applications appropriate for the purpose

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GEOSPATIAL PROGRAMMING	Basic competence in programming is useful, if not critical, for geospatial data handling and analysis	• Basic concepts of geospatial programming • Code libraries and APIs • Geospatial programming languages and IDEs • Customization of geospatial tools or applications • Design, development and implementation of geospatial applications	**Competencies** • Identify and describe the diversity and choice of programming languages and tools • Describe the technology trends **Learning Outcomes** • Demonstrate geospatial programming skills for data processing and spatial analysis. • Practice and experiment appropriate programming languages, APIs and IDEs

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GIS PROJECT DESIGN AND IMPLEMENTATION	Well thought out GIS project design contributes to effective project execution	• Concepts GIS project design and implementation • User requirements • Principles and methods of software engineering as applied to GIS development • Strategies, plans and procedures for implementing an effective GIS system • Example applications	**Competencies** • Define and identify elements of GIS projects • Describe challenges with implementing GIS with special reference to: data, people, technology and application, including benefits and limitations • Review strategies, plans and procedures for implementing an effective GIS system **Learning Outcomes** • Review and use appropriate implementation procedures and GIS development strategies that follow the general principles of business modeling, software engineering, standards, and project management