

**Canadian Board of Examiners for Professional Surveyors**  
**Core Syllabus Item**  
**C 5: GEOSPATIAL INFORMATION SYSTEMS**

**Syllabus Topics:**

Introduction to geospatial information systems (GIS) and geographic information science; Representations of geospatial data (vector and raster), data structures and topology; Data modeling and managing data in databases.

Introduction to query languages; Vector and raster data exploration, analysis and processing; Map as a presentation tool and types of maps; Cartographic design principles, presentations, thematic mapping and map generalization; Introductory visualization and graphic communications; Introduction to spatial modeling and analysis; Network representation and analysis; Spatial interpolation, surface modelling and analysis; Introduction to 3D GIS.

Data quality analysis, errors and natural variations; Geospatial data integration, metadata and standardization issues; Web GIS, mapping services and geospatial information dissemination; Access to information, privacy, security, and organizational structures (human resources, budget, institutional aspects); GIS project design and implementation.

**Recommended Prior Knowledge and Skills:**

Core Schedule Item C1: Mathematics

Core Schedule Item C4: Coordinate Systems and Map Projections

Understanding of basic principles of computer programming (equivalent to any introductory computer programming course offered to first-year, none computer science students)

**Learning Outcomes:**

The following lists the knowledge and skills that a candidate is expected to have in order to satisfy the requirements of this syllabus item. They are grouped into six high-level learning outcomes.

1. Describe the concepts, principles, techniques and applications that are fundamental to GIS and that differentiate GIS and geographic science from other information systems, technologies and sciences.
  - Define GIS terms as shown in the Glossary of GIS Terms in the appendix section of the essential reference.
  - Explain the basic concepts and principles associated with geospatial information management and systems, including how they differ from other information systems, and why.
  - Describe the functional basis of a GIS, including its classical three-tier architecture, major system components, typical software components (functions), and how it works.
  - Explain how the real-world is represented based on a feature model (i.e., point, line and area) in GIS.
  - Illustrate the range and diversity of GIS applications for solving real-world problems.
  - Describe the map projections and geo-referencing methods adopted in Canada and their importance to GIS.

- Use common GIS techniques for spatial query, analysis, modeling, and related scientific computing.
2. Explain the nature and characteristics of geospatial data, data representations, methods of data input and editing, and data organization/management in GIS.
    - Explain the main characteristics (spatial and thematic) of geospatial data.
    - Differentiate the vector and raster methods of geospatial data representation.
    - Explain how topological data is created and handled in GIS by recalling the concept of topology and topological data structures in relation to geospatial data.
    - Illustrate how commonly-used data editing methods (such as generalization, edge matching, rubber sheeting, and address geocoding) work.
    - Describe characteristics of DEM and TIN model.
    - Explain the concept of database, database management system, and how databases are linked to GIS following either relational database model or object-relational database model.
    - Outline GIS data modeling process by identifying and explaining the different levels of data abstraction (conceptual, logical and physical), data models and their features.
  3. Apply GIS concepts, principles and techniques to real-world spatial problem solving and mapping applications.
    - Differentiate between data, information and knowledge.
    - Discuss the difference between spatial information retrieval and analysis.
    - Compare vector and raster data in terms of data storage, analysis and representation.
    - Explain common data query and analysis operations available in a typical GIS.
    - Perform attribute-based and location-based (spatial) queries.
    - Perform spatial analysis using vector-based and raster-based buffering and overlay operations, and basic network analysis.
    - Categorize different spatial interpolation methods in terms of local vs. global and exact vs. inexact.
    - Discuss the characteristics of thematic maps (e.g., choropleth maps, dot map and graduate symbol maps) and general reference maps (e.g., topographic maps).
    - Explain the characteristics of measurement scales and their relationships to visual variables.
    - Apply basic cartographic principles, visual variables, and map symbology in map design and visualization in GIS.
    - Create process models for spatial (analytical) modeling under a set of constraints.
    - Demonstrate with examples how GIS analysis and modeling skills can be used to solve spatial problems
  4. Evaluate different GIS data collection 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.

- Describe the main sources of geospatial data and different GIS data acquisition methods, including digital terrain data.
  - Describe the types and sources of errors present in geospatial data.
  - Explain the main data quality indicators as included in most spatial data quality standards.
  - Outline the key data quality issues involved in using GIS.
  - Discuss the importance, possible usage, and components of spatial metadata as related to geospatial information management and GIS.
  - Explain briefly various types of standards related to geospatial information management and GIS.
  - Discuss why various data standards are important to GIS.
  - Use diagrams to explain how data interchange format works and the benefits of using a data interchange format.
5. Design appropriate implementation procedures and GIS development strategies that follow the general principles of business modeling, software engineering, and project management.
- Discuss the issues of implementing GIS with special reference to: data, people, technology and application.
  - Explain user requirements and how the user requirements may be acquired, defined and formally specified using a CASE tool or modeling language.
  - Recall the principles and methods of software engineering as applied to the development of GIS applications.
  - Contrast the benefits and shortcomings of using GIS in a specific application context.
  - Evaluate strategies, plans and procedures for implementing an effective GIS system.
  - Be aware of related organizational aspects (e.g., human resources, budget)
6. Outline the new developments on web-based mapping services and GIS for better geospatial information dissemination, decision support and applications.
- Describe the concepts of web GIS/mapping and web mapping services.
  - Describe different types of web mapping, including how their end users interact with client and server programs and their advantages and disadvantages.
  - Give examples of existing commercial web GIS/mapping software and online mapping services provided by the mainstream IT firms.
  - Compare between traditional GIS and web-based GIS and mapping services.
  - Identify some technical, organizational and social issues related to the development of web GIS/mapping and services.
  - Demonstrate the basic understanding of the implications of these new developments in geospatial information dissemination, decision support and applications.

**Essential Reference Material:**

Lo, C.P. and A.K.W., Yeung. [2007]. *Concepts and Techniques in Geographic Information Systems*. 2<sup>nd</sup>, Upper Saddle River, Prentice Hall (ISBN 0-13-149502-X)

*A balanced coverage of concepts and techniques in a single volume with review questions and additional references after each chapter; Chapters 1-7 and 9-12 are applicable to this syllabus item.*

**Supplementary Reference Material:**

Longley, P.A., M.F. Goodchild, D.J. Maguire and D.W. Rhind. [2007]. *Geographic Information Systems and Science*. 2<sup>nd</sup>, John Wiley & Sons (ISBN 978-0-470-87001-3)

*A textbook covering most contents required by this syllabus item*

Chang, K.T. [2008]. *Introduction to Geographic Information Systems*. 5<sup>th</sup>, McGraw Hill (ISBN 978-0-07-749436-6 )

*A well-written textbook covering most contents required by this syllabus item*

Clark A. L. [1991]. *GIS Specification, Evaluation, and Implementation, in Geographical Information Systems: Applications and Implementation*. John Wiley & Sons

*A bit dated, but presents a general model of GIS acquisition; it is helpful for understanding materials related to Learning Outcome 5. The full paper may be downloaded at:*

[www.wiley.com/legacy/wileychi/gis/Volume1/BB1v1\\_ch31.pdf](http://www.wiley.com/legacy/wileychi/gis/Volume1/BB1v1_ch31.pdf)

Roche, S. and C. Caron (editors). [2009]. *Organizational Aspects of GIS*. Wiley & Sons

*Chapters 3-6*

Croswell, P.L. (editor). [1998]. *Spatial Information Technology Standards and System Integration: Tutorial and Annotated Bibliography*. Published by the Urban and Regional Information Systems Association

*A good tutorial on geospatial standards although it is a bit dated; especially the 1st paper in Part I: Spatial Information Technology Standards Concepts, Issues, and Industry Status, by Peter L. Croswell*

Li, S. [2008]. Chapter 25: *Web mapping/GIS Services and Applications, in Advances in Photogrammetry, Remote Sensing and Spatial Information Sciences: 2008 ISPRS Congress Book*, edited by Li, Z., J., Chen and E., Baltsavias, CRC Press, Taylor & Francis Group (ISBN 0415478057)

*An overview of web mapping and GIS and their current developments with discussions on related social, organizational and technical issues*

Hardie, A. [1998]. *The Development and Present State of Web-GIS*. Cartography, 27(2)

Peng, Z.R. and M.H. Tsou. [2001]. *Internet GIS: Distributed Geographic Information Services for the Internet and Wireless Networks*, John Wiley & Sons, New Jersey, USA