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

Study Guide:

This guide presents some study questions with specific referral to the essential reference and some supplementary references. The list is by no means exhaustive, but should provide a helpful guidance to the study and examination preparation of the syllabus item.

The study questions are grouped into the six high-level learning outcomes described in the syllabus item description.

1.   With respect to describing 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:

Sample Questions:

Q1.1.   Why is it difficult to label if a piece of software is a GIS or not?

Q1.2.   What are the differences between a CAD system and a GIS?

Q1.3.   What are the similarities and differences between a GIS and a Land Information System?

Q1.4.   Describe how the following three classes of GIS users interact with GIS: (1) Viewers, (2) General Users, and (3) GIS Specialists.

Q1.5.   Discuss the role of each of the tree tiers in a generalized GIS software architecture.

Q1.6.   What types of questions could GIS help transportation managers address?

Q1.7.   What are the characteristics of a map? Why are maps important in GIS?

Q1.8.   Define map projection. Why is map projection necessary in map making?

Q1.9.   What's map re-projection?

Q1.10. Describe the origin, characteristics and applications of the Universal Transverse Mercator (UTM) coordinate system.

Q1.11. What is a classification scheme and feature code?

Q1.12. Describe the concept of layers in a geographic information system. Explain why we organize data in layers? Compile a list of common layers and the attached attributes that would likely be included in a GIS.

Q1.13. What are the factors that must be considered when developing a classification scheme?

Q1.14. Why is it necessary for GIS software to support both raster and vector formats?

Q1.15. Definitions or short explanations of the terms listed in Appendix B: Glossary of GIS Terms.

Suggested readings: Essential reference Concepts and Techniques in Geographic Information Systems by Lo and Yeung., Chapters 1, 2 and 3; also refer to other chapters and supplementary references Geographic Information Systems and Science by Longley, Goodchild, Maguire and Rhind, and Introduction to Geographic Information Systems by Chang for the basic definitions, terms, concepts, and techniques.

2. With respect to explaining the nature and characteristics of geospatial data, data representations, methods of data input and editing, and data organization/management in GIS:

Sample Questions:

Q2.1. List characteristics of vector and raster data model.

Q2.2. What are the relative merits and limitations of using raster and vector representations (in terms of data storage, data retrieval, data analysis, etc.)?

Q2.3. Give reasons why raster-to-vector conversion is difficult.

Q2.4. What is "topology"? Why is the concept of topology important for representing geographic information?

Q2.5. Using a simple diagram, explain the three types of topological relationships in geographic data representation.

Q2.6. Explain the use of topological relationship in geographic data processing.

Q2.7. Give examples of redundant data in a database.

Q2.8. What are the advantages and disadvantages of redundant data?

Q2.9. Why do we need explicit topological data in a GIS database?

Q2.10. What is topology building?

Q2.11. With the aid of one or more diagrams, explain the concept and process of geocoding by address matching.

Q2.12. What is the difference between a 2.5D and 3D model?

Q2.13. Are there any differences between a "digital terrain model" (DTM) and (i) "digital elevation model" (DEM) and (ii) "digital terrain elevation data" (DTED)?

Q2.14. What are the advantages of storing digital terrain in TIN rather than in DEM?

Q2.15. With the aid of a simple diagram, explain the components of a database management system (DBMS).

Q2.16. What are the advantages and disadvantages of storing geographic data in a DBMS?

Q2.17. Explain the limitations of conventional DBMS for geographic data management.

Q2.18. What is SQL? Give an example of using SQL to retrieve data from a relational table.

Q2.19. Given a GIS with two databases, one for spatial attributes and another one for non-spatial attributes, describe what the GIS software would have to do in order to retrieve the non-spatial attributes of a polygon identified by the user by pointing to it on the map display.

Q2.20. Similar to the previous questions, describe what the GIS software would have to do in order to draw the outline of the property identified by the user through a query using its non-spatial attributes.

Q2.21. What is conceptual data modeling?

Q2.22. Define the following terms in conceptual modeling using the entity-relationship (E-R) model: entities, entity types, relations, attributes, and cardinalities of relationships.

Q2.23. What is logical data modeling? What is the end product of logical data modeling?

Suggested readings: Essential reference <u>Concepts and Techniques in Geographic Information Systems</u> by Lo and Yeung, Chapters 2, 3, and Section 9.3 of Chapter 9; and supplementary references <u>Geographic Information Systems and Science</u> by Longley, Goodchild, Maguire and Rhind and <u>Introduction to Geographic Information Systems</u> by Chang.

3. With respect to applying GIS concepts, principles and techniques to real-world spatial problem solving and mapping applications:

Sample Questions:

Q3.1. How is data retrieval different from data analysis?

Q3.2. Discuss the difference between attribute-based and location-based (spatial) queries.

Q3.3. What is MBR? Briefly explain why we need MBR in spatial search and analysis.

Q3.4. With the aid of diagrams, explain and compare topological overlays based on UNION, INTERSECT, CLIP, and ERASE.

Q3.5. Explain the point-in-polygon operation.

Q3.6. Use a diagram and explain the line-in-polygon operation.

Q3.7. Explain the use of buffer zone generation and overlay in spatial analysis with an example.

Q3.8. Explain local and focal operations in raster geoprocessing.

Q3.9. Why is spatial modelling a difficult task?

Q3.10. Why do we say that a buffer zone is the simplest spatial model?

Q3.11. Why is it not feasible for commercial GIS software to include too many spatial modelling modules?

Q3.12. Explain the concept and application of network analysis.

Q3.13. Use a simple sketch to explain the basic elements that should be included in a map layout design.

Q3.14. Discuss any two of the commonly-followed design principles for the geographic contents included in a map.

Q3.15. What are the main visual variables used in map design?

Q3.16. Use sketches to explain inverse distance weighted (IDW) interpolation method.

Q3.17. Discuss the difference between exact and inexact interpolation methods.

Q3.18. An unnamed City police department claims: "80% of minor crimes in the downtown area are within 2000 feet of bars." You are given one digital map showing locations of minor crimes and another showing the locations of downtown bars. What procedure (steps, required data, queries and spatial operations, and outputs) will you follow to verify the claim?

Q3.19. You are asked to prepare a preliminary map that shows land parcels in a county that meet the following two criteria: (1) within 300 meters of streams, and (2) located in a conservation priority area. You are given three digital maps: streams map, land parcels map and the priority areas map (areas with different kinds of priorities). Describe the procedure (steps, required data, queries and spatial operations, and outputs) that you will use to complete the task.

4. With respect to evaluating 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:

Sample Questions:

Q4.1. List and briefly explain GIS data sources.

Q4.2. Describe in detail some commonly-used methods for collecting terrain data.

Q4.3. Compare different GIS data acquisition methods.

Q4.4. Describe the map digitizing procedures of converting a paper map into a GIS database with topological data structure (topology building process).

Q4.5. What is the difference between spaghetti digitizing and arc digitizing?

Q4.6. Explain the procedure of creating a topological database starting from map digitizing.

Q4.7. Explain why the increasing availability of digital geographic data has not been translated into increasing use of geographic data?

Q4.8. Explain the relationships between data ownership, copyright and cost recovery in the use of geographic data.

Q4.9. What is metadata? Why is the metadata important to GIS?

Q4.10. Describe at least four of the data elements for metadata. What are spatial metadata? What are the benefits of using metadata from both the user and producer perspectives? What are the major uses of metadata?

Q4.11. Why is data quality information difficult to obtain?

Q4.12. Explain the differences between "accuracy", "precision", "error" and "uncertainty".

Q4.13. What are "inherent" sources of data errors? What are "operational" sources of data errors?

Q4.14. Explain the following terms with special reference to geographic data: de facto standard, de jure standard, application standard, data standard, technology standard, and professional standard.

Q4.15. What are data transfer standards and interchange formats?

Q4.16. How does "data transfer without a common transfer format" differ from "data transfer with a common transfer format"? Why is it so difficult to develop a universally acceptable standard for data interchange?

Q4.17. Briefly describe the geographic data standards used in the United States or Canada.

Q4.18. Explain why data standard is important for "interoperability of GIS".

Q4.19. The collection of geographic data depends heavily on the use of new technology. Explain the data-related technology issues in GIS.

and supplementary references Geographic Information Systems and Science by Longley, Goodchild, Maguire and Rhind, Introduction to Geographic Information Systems by Chang, and Spatial Information Technology Standards and System Integration: Tutorial and Annotated Bibliography by Croswell (editor).

5. With respect to designing appropriate implementation procedures and GIS development strategies that follow the general principles of business modeling, software engineering, and project management:

Sample Questions:

Q5.1. What are the advantages of using the software engineering approach in GIS implementation?

Q5.2. List the activities of systems planning, starting from the forming of the systems planning team to the production of the application development plan.

Q5.3. Briefly explain the steps of evaluating and selecting GIS software

Q5.4. Briefly explain the steps of evaluating and selecting hardware for GIS implementation.

Q5.5. Describe the objectives and process of the following tasks in GIS implementation: populating the geographic database, application software development, software testing, and technology roll-out.

Q5.6. "The technology issues of GIS today have not very much to do with the lack of inadequacy of technology per se. Instead, they are concerned mainly with the ability of GIS users to evaluate and manage technology". Explain why.

Q5.7. Explain the three major GIS application issues: breadth and depth of application development; approach to application development; and integration with other types of technology.

Q5.8. Why is it necessary to develop customized applications by programming?

Q5.9. What is component software? Explain the impacts of using component software in GIS application program.

Q5.10. Explain the importance of graphical user interface (GUI) in the use of GIS.

Q5.11. What is "interoperability"? What are the advantages of interoperability in GIS? What has the GIS industry done to address the issues of interoperability?

Q5.12. Outline the steps involved in implementing a GIS in an organization that used to do only conventional mapping and inventory work. Can you suggest any problems or issues which should be addressed in each step?

Q5.13. For a GIS project, write a short essay arguing about whether the required GIS software should be developed in house or purchased from a commercial company (GIS software vendor).

Suggested readings: Chapters 11 and 12, and supplementary references # 3 and 4

Suggested readings: Essential reference Concepts and Techniques in Geographic Information Systems by Lo and Yeung, Chapters 11 and 12; and supplementary references GIS Specification, Evaluation, and Implementation, in Geographical Information Systems: Applications and Implementation by Clark, and Organizational Aspects of GIS by Roche and Caron (editors).

6. With respect to outlining the new developments on web-based mapping services and GIS for better geospatial information dissemination, decision support and applications:

Sample Questions:

Q6.1. What is client/server computing?

Q6.2. With the aid of a diagram, describe the client/server architecture of GIS.

Q6.3. Compare think-client and thick-client options in design a web-based mapping or GIS application.

Q6.4. What are the characteristics of early static map publishing technology?

Q6.5. How is the interactive web mapping different from static web mapping?

Q6.6. Explain the impacts of the Internet and Web on GIS developments.

Q6.7. How do you think the web map services provided by the mainstream IT firms such as Google and Yahoo will affect the GIS development?

Q6.8. How do the free online web map services such as Google Maps, Yahoo! Maps, and MapQuest improve your daily life or work?

Q6.9. How have concepts and methods of "enterprise computing" affected GIS development in recent years?

Q6.10. Explain the concept, characteristics and application of a spatial data warehouse, catalogue service, or portal.

Suggested readings: Essential reference Concepts and Techniques in Geographic Information Systems by Lo and Yeung, Section 7.6.4, 12.4; and supplementary references Chapter 25: Web mapping/GIS Services and Applications, in Advances in Photogrammetry, Remote Sensing and Spatial Information Sciences: 2008 ISPRS Congress Book by Li, S., The Development and Present State of Web-GIS by Hardie, and Internet GIS: Distributed Geographic Information Services for the Internet and Wireless Networks by Peng and Tsou.