International Institute of Information Technology, Hyderabad

Spatial Informatics (GS2.401)
Monsoon 2025

Time: 90 minutes **Total Marks: 45**

Note: If needed, make suitable assumptions and state them clearly when answering. No doubts will be clarified during the exams. Use figures appropriately to better communicate your idea and approach.

Part I. Multi Select Questions **8 x 2m= 16m**

[Choose the correct answer/s. One or more answers may be correct]

1) Select the valid statements regarding vector data structures.
   a. Spaghetti model preserves the topological relationships between spatial objects
   b. Polygon-Arc topology inherently makes sure that no two polygons overlap
   c. Arc-polygon topology captures the adjacency relationships between two polygons.
   d. Vertex dictionary stores the topological relationships by avoiding duplications of vertices.
2) Which of the following represent topological properties?
   a. IIIT campus area is around 66 acres
   b. CR Rao road is connected to the entry gate
   c. Vindhya canteen is located on the south-east direction of the football ground
   d. New construction site inside the campus
3) Select all valid components of any map projection system.
   a. Latitude of the origin + central meridian
   b. Standard parallels
   c. False easting and false northing
   d. Projection type (e.g., Conic, Cylindrical, Azimuthal)
4) By digitizing we convert the geographic features into their digital representation such that they can be stored and processed by a computer. What are the topological constraints you wouldn't apply while digitizing agriculture farms in a village?
   a. Two neighbouring farms can overlap
   b. Two neighbouring farms cannot overlap
   c. A boundary line segment of the farm can have more than two neighbouring farms (including itself)
   d. Corners of the farm may belong to itself and other neighbouring farms
5) Mark wrong statements with respect to the Sentinel-2 data with 10 m spatial resolution (SR) and LISS-IV data with 5.8 m (SR)
   a. The sentinel data visualized at 1:50K is a high-resolution data than when visualized at 1:100K
   b. LISS-IV spatial resolution is higher than Sentinel data

c. At the scale of 1:100K, both the data provide same level of details
d. It is possible to down-sample LISS-IV data to ~10 m SR using focal operation

6) For a transportation network map such as metro network, select the statements that are correct (Metr map here refers to the map displayed within a metro train with info regarding the preceding and succeeding stations)
   a. Metro map is topologically equivalent to the actual network on the ground
   b. Metro map correctly represents the distance between two stations
   c. Connectedness between two stations is often misrepresented in the metro map
   d. A metro line on the ground with a curved shape like the letter "S" can be represented as a straigh line in the map
7) Which of the following can be represented as both vector and raster
   a. Roads with widths
   b. Property owned by individuals or organisations
   c. A buffer of the air pollution around a road
   d. National Forests
8) Select statements that are valid for a raster model of spatial data
   a. Raster model better describes the discrete geographic objects
   b. Focal operation may use grid cell values from a 3×3 neighborhood of a grid position
   c. A raster map with the "bigger numerical value" of the spatial resolution provides more details
   d. Temperature, precipitation, and elevation can be better represented by raster model

Part II. Answer the following **2 x 2m = 4m**

9) State the spatial overlay type/function for the following settings
   a. District wise (polygon) count of health care facilities (point locations)
   b. Extracting districts (polygons) from Telangana (state polygons)
   c. Finding road segments (line) passing through forest areas (polygons).
   d. Creating a new polygon layer where each feature carries both land use and soil type attributes (inputs: polygon landuse + polygon soil type).

10) Classify the following operations into local, focal, and zonal/global (Hint: draw a figure for better representation)
   a. Deriving a map of "surface waterbodies" by reclassifying lakes/ponds, and rivers
   b. Creating a shortest distance map from two source locations in the raster map

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Part III. Answer the following **5 x 3m = 15m**

11) A LISS-III imagery dataset for a region that has predominantly vegetation types and has data containing SWIR, NIR, and Red and Green Bands. You have an option to save it in one of the primary raw raster formats – BIP or BSQ or BIL.

a. State which of them will you choose and why, if you have to compute vegetation index over the region?

b. What are the consequences of storing them in the raw formats other than the one chosen above?

12) After detecting waterbodies using NDWI using simple thresholding approach and further polygonising them, it was observed that the process created spurious tiny polygons, sometimes of the size of one pixel. In this context, answer following:

a. What could be the contribution factors to this artifact? And possible remedy to reduce such tiny waterbodies?

b. Other than NDWI, which other index can be used to improve the waterbody detection? Explain how?

13) Provide an example real-world application where you will combine both focal and zonal operations

a. Describes a sample input dataset, specifying what each grid cell represents. If you are using another input raster data describe that too.

b. Describe how are you combining these two operations to derive the output map.

14) For handling spatial data, why do we need a raster model? Argue whether the vector model is sufficient or insufficient in the following scenarios:

a. to represent the footprint of the houses

b. to represent population density at each location in an urban area marked as residential, industrial, commercial zones.

15) Seasonal variations (e.g., waterbodies shrinking in summer and expanding in monsoon, or Kharif vs. Rabi cropping cycles) affect how land cover is observed. Since LULC maps are typically generated annually, explain how you would account for seasonality in order to generate an accurate annual LULC map. Clearly mention the procedure, data, and spatial functions (if any) used. Explain your answer using land use/cover class of your choice with seasonal variability.

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Part IV. Answer any two of the following **2 x 5m = 10m**

16) Regarding topological relationships:

a. State any two topological relationships between two polygonal objects, draw example configurations and state the factors that determine these relationships [3M]

b. Pick any topological relationship from above and explain your method to determine it between two raster objects based on the factors you have mentioned above? Explain with a figure. [2M]

17) The Mumbai–Hyderabad highway is being expanded from 4 lanes (45 m) to 8 lanes (90 m). You are provided with highway network data (line) and a LULC map (raster). Assume any additional data you consider necessary.

a. Design a workflow to estimate how much area of each LULC class will be affected by the expansion. Assume few major LULC classes that you found in the map during assignment [2.5M]

b. Propose a strategy to decide where flyovers should be planned and where land acquisition/compensation might be required, based on the impacted LULC classes. [2.5M]

18) If a printed circuit board (PCB) is to be represented as a spatial dataset, answer following:

a. List various components and their data types. [1M]

b. Explain with example how spatial relationships are important in PCB design. [1M]

c. Suggest at least two topology rules can be applied to detect and correct design errors. [2M]

d. Briefly discuss one advantage of using GIS-like spatial data management concepts in electronic design automation. [1M]