Tribhuvan University
Institute of Science and Technology
Model Question, 2079

Bachelor Level/ Fourth Year/ Eighth Semester/Science **Full Marks: 60**
Computer Science and Information Technology (CSC468) **Pass Marks: 24**
(Geographical Information System) **Time: 3 hours**

Section A Attempt any two questions. (2 × 10 = 20)

1. Define geographical object and field. Differentiate between raster and vector data models with illustrations. [10]

Geographic Fields - A geographic field is a geographic phenomena whose value at every point in the study area can be determined. If (x,y) represents the study area, then f(x,y) represents the value of the geographic field at that point. A geographic field can be discrete or continuous. The changes in the field values are gradual. The continuous field can be differentiated. The discrete field divide the study area in mutually exclusive and bounded parts, with all locations in a single part having same field value. The natural geographic phenomena are generally geographic fields. Eg: temperature, elevation and so on.

Geographic Objects –

A geographic object is a geographic phenomena whose value is determined only at certain points in the study area. - It represents well distinguishable discrete entities. In between the geographic objects, there is presence of empty spaces. The position of geographic object is determined by a combination of one or more parameters such as location, shape, size and orientation. The artificial geographic phenomena are generally geographic objects. Eg: building, road, temple and so on.

vector data model: [data models] A representation of the world using points, lines, and polygons. Vector models are useful for storing data that has discrete boundaries, such as country borders, land parcels, and streets.

raster data model: [data models] A representation of the world as a surface divided into a regular grid of cells. Raster models are useful for storing data that varies continuously, as in an aerial photograph, a satellite image, a surface of chemical concentrations, or an elevation surface.

Latitudes and Longitudes in Vector data are displayed in the form of lines, points, etc. Latitudes and Longitudes in Raster data are displayed in the form of closed shapes where each pixel has a particular latitude and longitude associated with it.

Vector data	Image data
Use points and lines to represent features	Represented as 2-dimensional array of brightness values for pixels
Resolution is determined by precision of vertices' coordinates	Resolution is determined by pixel size
Efficiently represents sparse data	Efficiently represents dense data
Spatial relations exist	Spatial relations do not exist
Efficient storage of sparse data	Requires large amounts of storage space
Small redundancy to hide watermark	Considerable redundancy to hide watermark
Explicit representation of linear features	Deals poorly with linear features

Raster	Vector
Comprised of pixels, arranged to form an image	Comprised of paths, dictated by mathematical formulas
Constrained by resolution and dimensions	Infinitely scalable
Capable of rich, complex color blends	Difficult to blend colors without rasterizing
Large file sizes (but can be compressed)	Small file sizes
File types include .jpg, .gif, .png, .tif, .bmp, .psd; plus .eps and .pdf when created by raster programs	File types include .ai, .cdr, .svg; plus .eps and .pdf when created by vector programs
Raster software includes Photoshop and GIMP	Vector software includes Illustrator, CorelDraw, and InkScape
Perfect for “painting”	Perfect for “drawing”
Capable of detailed editing	Less detailed, but offers precise paths

2. What are different coordinate and projection systems used in GIS mapping. Explain in brief. [10]

Common Map Projections:
Hundreds of map projections are in use. Commonly used map projections in GIS are not necessarily the same as those we see in classrooms or in magazines. For example, the Robinson projection is a popular projection for general mapping at the global scale because it is aesthetically pleasing (Jenny, Patterson, and Hurni 2010). But the Robinson projection may not be suitable for GIS applications. A map projection for 20 Prepared by Purusottam Adhikari GIS applications usually has one of the preserved properties mentioned earlier, especially the conformal property. Because it preserves local shapes and angles, a conformal projection allows adjacent maps to join correctly at the corners. This is important in developing a map series such as the U.S. Geological Survey (USGS) quadrangle maps.

Transverse Mercator
The transverse Mercator projection, a secant cylindrical projection also known as the Gauss-Kruger, is a well-known projection for mapping the world. It is a variation of the Mercator projection, but the two look different. The Mercator projection uses the standard parallel, whereas transverse Mercator projection uses the standard meridian. Both projections are conformal. The definition of the projection requires the following parameters: scale factor at central meridian, longitude of central meridian, latitude of origin (or central parallel), false easting, and false northing.

Lambert Conformal Conic
The Lambert conformal conic projection is a standard choice for mapping a midlatitude area of greater east–west than north–south extent, such as the state of Montana or the conterminous United States (Figure 2.11). The USGS has used the Lambert conformal conic for many topographic maps since 1957. Typically a secant conic projection, the Lambert conformal conic is defined by the following parameters: first and second standard parallels, central meridian, latitude of projection’s origin, false easting, and false northing

Albers Equal-Area Conic
The Albers equal-area conic projection has the same parameters as the Lambert conformal conic projection. In fact, the two projections are quite similar except that one is equal area and the other is conformal. The Albers equal-area conic is the projection for national land cover data for the conterminous United States.

Equidistant Conic
The equidistant conic projection is also called the simple conic projection. The projection preserves the distance property along all meridians and one or two standard parallels. It uses the same parameters as the

Lambert conformal conic.

Web Mercator

Unlike the transverse Mercator, as well as other projections covered in the previous sections, which were all invented before the end of the eighteenth century (Snyder 1993), the Web Mercator projection is a new invention, probably made popular by Google Maps in 2005 (Battersby et al. 2014). It has since become the standard projection for online mapping, as Google Maps, Bing Maps, MapQuest, and ArcGIS Online all use it in their mapping systems. What is Web Mercator? It is a special case of the Mercator on a sphere and projected from latitude and longitude coordinates from the WGS84 ellipsoid (Battersby et al. 2014). A main advantage of using a sphere is that it simplifies the calculations. Also, because it is a conformal projection, the Web Mercator projection preserves local angles and shapes and has north at the top of the map. However, like the Mercator, the Web Mercator projection has area and distance distortions, especially in high latitude areas. A GIS package has tools for reprojecting Web Mercator to other projections and vice versa

Projected Coordinate Systems

The Universal Transverse Mercator Grid System

The Universal Transverse Mercator Grid System Used worldwide, the UTM grid system divides the Earth's surface between 84° N and 80° S into 60 zones. Each zone covers 6° of longitude and is numbered sequentially with zone 1 beginning at 180° W. Each zone is further divided into the northern and southern hemispheres. The designation of a UTM zone therefore carries a number and a letter. For example, UTM Zone 10N refers to the zone between 126° W and 120° W in the northern hemisphere

Military Grid Reference System (MGRS)

MGRS is an extension of the UTM system. UTM zone number and zone character are used to identify an area 6 degrees in east-west extent and 8 degrees in north-south extent. UTM zone number and designator are followed by 100 km square easting and northing identifiers. The system uses a set of alphabetic characters for the 100 km grid squares. Starting at the 180 degree meridian the characters A to Z (omitting I and O) are used for 18 degrees before starting over. From the equator north the characters A to V (omitting I and O) are used for 100 km squares, repeating every 2,000 km. The reverse sequence (from V to A) is used for southern hemisphere

The Universal Polar Stereographic Grid System

The UPS grid system covers the polar areas. The stereographic projection is centered on the pole and is used for dividing the polar area into a series of 100,000-meter squares, similar to the UTM grid system. The UPS grid system can be used in conjunction with the UTM grid system to locate positions on the entire Earth's surface.

The State Plane Coordinate System

The SPC system was developed in the 1930s to permanently record original land survey monument locations in the United States. To maintain the required accuracy of one part in 10,000 or less, a state may have two or more SPC zones. SPC were developed in order to provide local reference system that were tied to a national datum

3. How Remote Sensing is different from GPS? Explain how Remote Sensing works? Differentiate between active and passive sensor? [10]

Remote sensing is a GIS data collection and processing technique. GPS (global positioning system) is a way to assign a location to a point on the Earth. Remote sensing is the use of sensors on board either planes or satellites to collect data usually in a grid like pattern of pixels called raster data.

The main tasks of GPS are sorting out the placement coordinates of the user on any place on the planet. The satellites utilized in GPS are entirely developed to produce service for GPS. Any user on earth with smart visibility and a well-equipped GPS receiver will get his point information in regards to Latitude, Longitude, Height. This method uses the ‘trilateration’ technique to figure the user location.

Remote Sensing technology’s main tasks are gathering information concerning the surface of the planet from afar off-platform, typically with a satellite or mobile sensing element. Most remotely perceived information used for mapping and spatial analysis is collected as mirrored non-particulate radiation that is processed into a digital image which is then overlaid with different spatial information.

Remote sensing is art ,science or technology to detect something through a distance without a direct physical contact.

It is basically a multidisciplinary science which includes many disciplines such as optics, spectroscopy, photography, computer and satellite launching.

There are different stages in remotesensing process.

1.Emission of electromagnetic radiation

2.Transmission of energy from source to earth's surface.

3.Interaction of EMR with earth's surface.

4.Transmission of energy from surface to remote sensor.

5. Sensor data output.

6.Data transmission, processing and analysis.

Its has many applications in the field urbanization, metrology, oceanography, minerology, geology, space technology etc

Active sensors have their own source of light or illumination. In particular, it actively sends a pulse and measures the backscatter reflected to the sensor.

But **passive sensors** measure reflected sunlight emitted from the sun. When the sun shines, passive sensors measure this energy.

Active sensor :
An active sensor is transducer generates electric current or voltage directly in response to environmental stimulation.

Active sensor both transmit and measure electromagnetic energy.

Active sensor self destructs during hijack attempts.

Active sensor actively transmits measurement to ground stations whether the personnel on duty want the data or not.

The active sensor emits their own EM energy which is transmitted towards the earth and receives energy reflected from the earth. The received EM(electromagnetic) energy is used for measurement purpose.

It provides their own energy source for illumination.

Active sensors are able to obtain measurement anytime.

Example of active sensor like communication satellite, earth observation satellite, LISS -1, etc.

Passive sensor :

The passive sensor is transducer produces a change in some passive electrical quantity such as capacitance, resistance or inductance as a result of the stimulation. These usually require additional electrical energy for excitation.

The passive sensor only measures electromagnetic energy.

The passive sensor has no defence against enemy attack.

Passive sensors wait patiently until data are requested.

The passive sensor receives naturally emitted EM energy within its field of view and performs measurement using it.

Passive sensors can only be used to detect energy when naturally when the naturally occurring energy is available.

Passive sensors can obtain measurement only in the day time.

Example of passive sensor like remote sensing satellite, SPOT-1, LANDSAT-1, etc.

Section B Attempt any eight questions. (8 × 5 = 40)

4. Explain the functions of a GIS. How GIS is different from other Database Management System (DBMS)? [5]

Functions of GIS:

Data Collection and Capture:

Remote sensing images, existing maps, tabular data, ground survey, internet etc. are used to collect data as input data to GIS process. These input sources can be used to create digital data through digitization process using GIS software and computer.

Data Storage and Management:

Database created through GIS can be stored into different media such as hard disk, DVD, USB drive, online drive and also on cloud. Spatial database can be updated regularly by acquiring time to time new input sources. This is the most advantageous function as all the data in digital form, therefore to update data is very easy and reduce the data redundancy

Data Integration:

GIS makes it possible to link or integrate information collected from different sources. Thus, GIS can be used in combinations to map variables to create and analyze new variables and factors. For example, GIS technology, it is possible to combine agricultural depth and its physical and chemical quality parameters. This help to understand the water demand and impact of water quality on crop yield.

Data Conversion:

It is very important function as it facilitates to analyze data, which are collected from different sources in better way. Such as Jpeg file can be converted into tiff format, conversion of projection to have all data in same projection system through georeferencing(raster to vector)

Data Analysis:

Data can be analyzed by applying appropriate mathematical or statistical algorithms on data to generate new information/maps. It is completely depends on users requirement for example buffer analysis, proximity analysis and interpolation process to create DEM etc.

A database management system (DBMS) serves as an interface between users and their databases. A spatial database includes location. It has geometry as points, lines, and polygons. **GIS combines spatial data from many sources with many different people**.

5. Describe the main ways of acquiring data for input into a GIS. [5]

- Data input is the process of encoding collected data into computer readable form and inserting the encoded data into the GIS database. The different types of data input methods are as follows:

1. Manual:

- Manual data entry is done if the data are collected or measured data manually. - The data exists as a text file or binary file.

2. Digitizing:

- It is the process of capturing data on a map and putting into a computer file. - It can be manual or automatic. - Manual digitizing allows geo-referencing during the digitization process. - Automatic digitizing requires geo-referencing in later stages.

3. Scanning:

- A digital image of map is produced by moving an electronic detector across the surface of the map. The output is a digital image.

4. Remote Sensing:

- It is the science of making measurements of the Earth using sensors on satellites or airplanes. - The sensors collect data in the form of images and provide capabilities to manipulate, analyze and view the images.

5. Photogrammetric Compilation:

The primary source used in the process of photogrammetric compilation is aerial photography. Generally, the process involves using specialized equipment (a stereoplotter) to project overlapping aerial photos so that a viewer can see a three-dimensional picture of the terrain, known as a photogrammetric model. The current technological trend in photogrammetry is toward a greater use of digital procedures for map compilation.

6. Satellite data:

Earth Resources Satellites have become a source of huge amount of data for GIS applications. The data obtained from the Satellites are in digital form, which can be directly imported to GIS. There are numerous satellite data sources such as LANDSAT or SPOT. A new generation of high-resolution satellite data that will increase opportunities and options for GIS database development is becoming available from private sources and national governments. These satellite systems will provide panchromatic (black and white) or multi-spectral data in the 1- to 3-meter ranges as compared to the 10- to 30-meter range available from traditional remote sensing satellites.

6. Describe the different types of vector overlay operations with suitable examples. [5]

In a point-in-polygon overlay operation, the same point features in the input layer are included in the output but each point is assigned with attributes of the polygon within which it falls (Figure 11.6). For example, a point-in-polygon overlay can find the association between wildlife locations and vegetation types

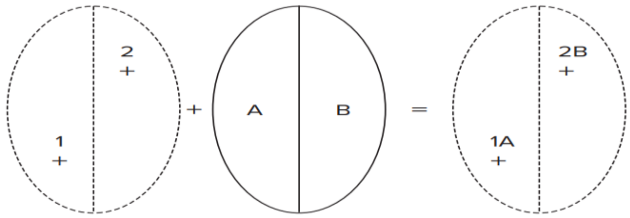


Figure 11.6
Point-in-polygon overlay. The input is a point layer. The output is also a point layer but has attribute data from the polygon layer.

In a **line-in-polygon** overlay operation, the output contains the same line features as in the input layer but each line feature is dissected by the polygon boundaries on the overlay layer (Figure 11.7). Thus the output has more line segments than does the input layer. Each line segment on the output combines attributes from the input layer and the underlying polygon. For example, a line-in-polygon overlay can find soil data for a proposed road. The input layer includes the proposed road. The overlay layer contains soil polygons. And the output shows a dissected proposed road, with each road segment having a different set of soil data from its adjacent segments.

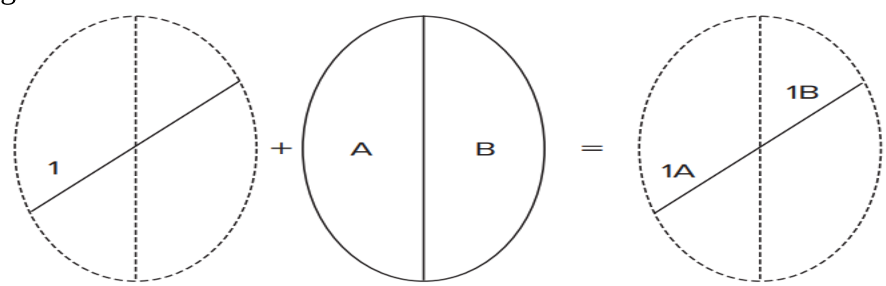


Figure 11.7
Line-in-polygon overlay. The input is a line layer. The output is also a line layer. But the output differs from the input in two aspects: the line is broken into two segments, and the line segments have attribute data from the polygon layer.

The most common overlay operation is polygon-on-polygon, involving two polygon layers. The output combines the polygon boundaries from the input and overlay layers to create a new set of polygons (Figure 11.8). Each new polygon carries attributes from both layers, and these attributes differ from those of adjacent polygons. For example, a polygon-on-polygon overlay can analyze the association between elevation zones and vegetation types.

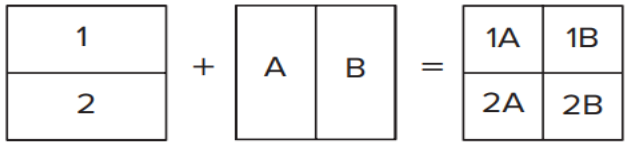


Figure 11.8
Polygon-on-polygon overlay. In the illustration, the two layers for overlay have the same area extent. The output combines the geometries and attributes from the two layers into a single polygon layer.

7. What are the different errors in GPS? How they can be corrected? [5]

SATELLITE ERRORS:

Slight inaccuracies in time keeping by the satellites can cause errors in calculating our positions. Similarly, the satellite's position in space is equally important as it is the starting point of the calculations. Although the GPS satellites are at very high orbits and are relatively free from the perturbing effects of atmosphere, they still drift slightly from their predicted orbits which contributes to our errors.

THE ATMOSPHERE

The GPS signals have to travel through charged particles and water vapour in the atmosphere which delays its transmission. Since the atmosphere varies at different places and at different times, it is not possible to accurately compensate for the delays that occur.

Multipath error

As the GPS signal finally arrives at the earth's surface, it may be reflected by local obstructions before it gets to the receiver's antenna. This is called multipath error as the signal is reaching the antenna by multiple paths.

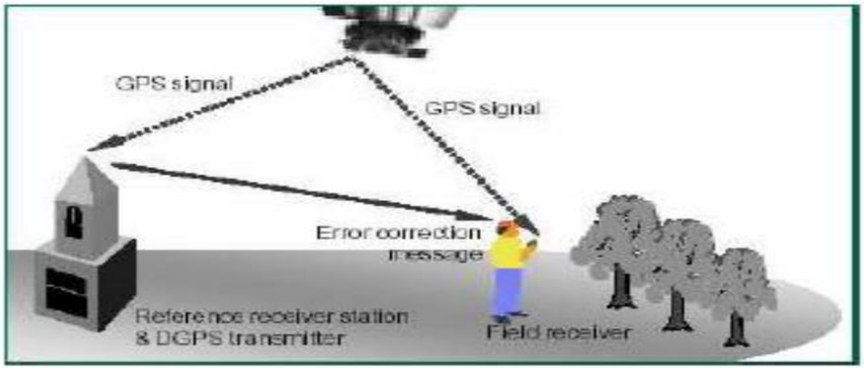
RECEIVER ERROR

Since the receivers are also not perfect, they can introduce their own errors which usually occur from their clocks or internal noise.

SELECTIVE AVAILABILITY

Selective availability (SA) was the intentional error introduced by DoD to make sure that no hostile forces used the accuracy of GPS against the US or its allies. It introduced some noise into the GPS satellite clocks which reduced their accuracy. The satellites were also given some erroneous orbital data which was transmitted as a part of each satellite's status message. These two factors significantly reduced the accuracy of GPS in civilian uses. On May 1st, 2000, the White House announced a decision to discontinue the intentional degradation of the GPS signals to the public. Civilian users of GPS will be able to pinpoint locations up to ten times more accurately. The decision to discontinue SA is the latest measure in an on-going effort to make GPS more responsive to civil and commercial users worldwide.

To eliminate most of the errors discussed above, the technique of differential positioning is applied. Differential GPS carries the triangulation principle one step further, with a second receiver at a known reference point. The reference station is placed on the control point - a triangulated position or the control point coordinate. This allows for a correction factor to be calculated and applied to other roving GPS units used in the same area and in the same time series. This error correction allows for a considerable amount of error to be negated, potentially as much as 90 per cent. The error correction can either be post processed or on real time



8. Describe the basic elements of the raster data model. Why a local operation is also called a cell-by-cell operation? [5]

Basic elements of raster data model

1.Cell value.

Each cell in a raster carries a value, which represents the characteristic of a spatial phenomenon at the location denoted by its row and column. The cell value can be integer or floating-point.

2. Cell size.

The cell size determines the resolution of the raster data model.

3. Raster bands.

A raster may have a single band or multiple bands.

4. Spatial reference.

Raster data must have the spatial reference information so that they can align spatially with other data sets in a GIS.

Local operations, or per-cell functions, compute a raster output dataset where the output value at each location (cell) is a function of the value associated with that location on one or more raster datasets. A local operation can create a new raster from either a single input raster or multiple input rasters. The cell values of the new raster are computed by a function relating the input to the output or are assigned by a classification table.

A local operation involves the production of an output value as a function of the value(s) at the corresponding locations in the input layer(s). These operations can be considered point operations when performed on raster data, i.e. they operate on a pixel and its matching pixel position in other layers, as opposed to groups of neighbouring pixels. They can be grouped into those which derive statistics from multiple input layers (e.g. mean, median, minority), those which combine multiple input layers, those which identify values that satisfy specified criteria or the number of occurrences that satisfy specified criteria (e.g. greater than or less than), or those which identify the position in an input list that satisfies a specified criterion. All types of operator previously mentioned can be used in this context. Commonly they are subdivided according to the number of input layers involved at the start of the process. They include primary operations where nothing exists at the start, to n-ary operations where n layers may be involved;

9.. Why do you most likely use a vector-based buffering operation, rather than a raster-based physical distance measure operation? Explain with examples. [5]

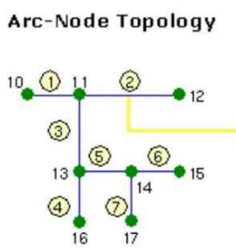
A vector-based buffering operation and a raster based physical distance measure operation are similar in that they both measure distances from select features. But they differ in at least two aspects. First, a buffering operation uses x- and y-coordinates in measuring distances, whereas a raster-based operation uses cells in measuring physical distances. A buffering operation can therefore create more accurate buffer zones than a raster-based operation can. This accuracy difference can be important, for example, in implementing riparian zone management programs. Second, a buffering operation is more flexible and offers more options. For example, a buffering operation can create multiple rings (buffer zones), whereas a raster-based operation creates continuous distance measures. Additional data processing (e.g., Reclassification or Slice) is required to define buffer zones from continuous distance measures. A buffering operation has the option of creating separate buffer zones for each select feature or a dissolved buffer zone for all select features. It would be difficult to create and manipulate separate distance measures using a raster-based operation.

10. Explain what connectivity, adjacency and containment mean in vector topology. Provide an example for each. [5]

Three basic topological relationships are usually stored: connectivity, adjacency, and enclosure. **Connectivity** describes how lines are connected to each other to form a network. **Adjacency** describes whether two areas are next to each other, and **enclosure** describes whether two areas are nested.

Connectivity

Connectivity is a geometric property used to describe the linkages between line features, like road network. Connectivity allows you to identify a route to the airport, connect streams to rivers, or follow a path from the water treatment plant to a house. This is the basis for many network tracing and path finding operations. In the arc-node data structure, arcs connect to each other at nodes and have both a from-node (i.e., starting node) indicating where the arc begins and a to-node (i.e., ending node) indicating where the arc ends. This is called arc-node topology. Arc-node topology is supported through an arc-node list. The list identifies the fromand to-nodes for each arc. Connected arcs are determined by searching through the list for common node numbers. In Figure No 3, arcs 1, 2, and 3 all intersect because they share node 11. It is possible to travel along arc 1 and turn onto arc 3 because they share a common node (11), but it is not possible to turn directly from arc 1 onto arc 5 because they do not share a common node. Connectivity answers which line segments are connected?" for network analysis.



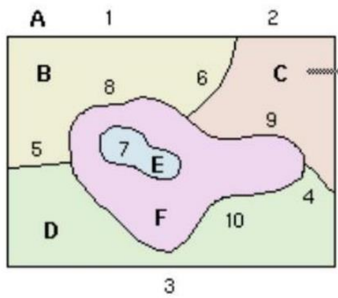
Arc-Node List

Arc	From Node	To Node
1	10	11
2	11	12
3	11	13
4	13	16
5	13	14
6	14	15
7	14	17

Figure No 3: Arc-Node Topology example

Area definition/ containment

Containment is an extension of the adjacency that describes area features which may be wholly contained within another area feature. For instance, an island defines an inner boundary (or hole) of a polygon. The lake actually has two boundaries: one that defines its outer edge and the island that defines its inner edge. In the terminology of the vector model, an island defines an inner boundary (or hole) of a polygon. The arc-node structure represents polygons as an ordered list of arcs rather than a closed loop of x, y coordinates. The arc-node structure represents polygons as an ordered list of arcs rather than a closed loop of (x, y) coordinates – known as polygon-arc topology. In Figure No 4, polygon F is made up of arcs 8, 9, 10, and 7 (the 0 before the 7 indicates that this arc creates an island in the polygon). Each arc appears in two polygons (in the illustration below, arc 6 appears in the list for polygons B and C). Since the polygon is simply the list of arcs defining its boundary, arc coordinates are stored only once, thereby reducing the amount of data and ensuring that the boundaries of adjacent polygons do not overlap. Containment answers, "Which spatial features are contained within which?" and used for selection or geocoding



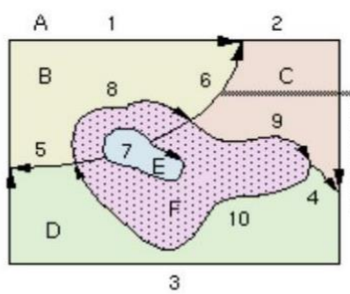
Polygon-Arc Topology

Polygon	Arc List
B	1, 6, 8, 5
C	2, 4, 9, 6
D	3, 5, 10, 4
E	7
F	8, 9, 10, 0, 7

Figure No: 4. Polygon-Arc Topology example

Contiguity or adjacency:

Contiguity is the topological concept that allows the vector data model to determine adjacency of features share a boundary. This is the basis for many neighbor and overlay operations. Areas can be described as being adjacent when they share a common boundary. The from-node and the to-node define an arc. Arcs have direction and left and right sides so the polygons on its left and right sides can be determined. In Figure No 5, polygon B is on the left of arc 6, and polygon C is on the right. Thus, polygons B and C are adjacent. Notice that the label for polygon A is outside the boundary of the area. This polygon is called the external, or universe, polygon and represents the world outside the study area. The universe polygon ensures that each arc always has a left and right side. Adjacency answers "Which polygons are adjacent to which?" and used in spatial analysis of areal data.



Left-Right Topology

Arc	Left Polygon	Right Polygon
1	A	B
2	A	C
3	A	D
4	C	D
5	D	B
6	B	C
7	F	E
8	B	F
9	C	F
10	D	F

Figure No:5. Topology contiguity example

11. Describe spatial data infrastructure. Mention the contents of Metadata. [5]

Spatial data Infrastructure:

-SDI is defined as the collection of technologies, policies and institutional arrangements that

facilitates the availability and access to spatial data.
- It provides basis for spatial data discovery, evaluation and application for users and providers.
- It encompasses resources, systems, network linkage, standards and institutional issues involved from many different sources in delivering the geo-spatial information to the potential users.
- The main aim of SDI can be expressed as follows:
1. To link existing and upcoming databases of the respective level. (Represented by product based model)
2. To define a framework to facilitate the management of information assets. (Represented by process based model)

Metadata is defined as background information that describes the content, quality, condition and other appropriate characteristics of the data. So metadata is a simple mechanism to inform others of the existence of the data sets, their purpose and scope. In essence metadata answer who, what, when, where, why and how questions (WH Questions) about all facets of the data made available. Metadata can be used internally be the data provider to monitor the status of data sets, and externally to advertise to potential users through a national clearinghouse. Metadata are important in the production of a digital spatial data clearinghouse, where potential users can search for the data they need.

Roles of metadata:

Applicability: information needed to determine the data sets that exists for a geographic location, **Fitness for use:** information needed to determine whether a data set meets a specified need**, Access:** information needed to acquire an identified data set, **Transfer:** information needed to process and use a data set, **Administration**: information needed to document the status of existing data (data model, quality, completeness, temporal validity etc…) to define internal policy for update operations from different data sources

12. Write short notes on:

a) Geoid and Ellipsoids

The geoid and ellipsoid models are used in today's global positioning satellite (GPS) systems. GPS systems use the ellipsoid model as a baseline to measure the elevation of a particular location on Earth. However, some GPS system now use the geoid model to better represent the elevations. Accurate measurements are most useful to topographers, whose job is it to develop as precise measurements of the Earth's surface as possible.

Ellipsoid

Ellipsoid comes from the word "ellipse," which is simply a generalization of a circle. Ellipsoids are generalizations of spheres. The Earth is not a true sphere, it is an ellipsoid, as Earth is slightly wider than it is tall. Although other models exist, the ellipsoid is the best fit to Earth's true shape.

Geoid

Like the ellipsoid, the geoid is a model of the Earth's surface. According to the University of Oklahoma, "the geoid is a representation of the surface of the earth that it would assume, if the sea covered the earth." This representation is also called the "surface of equal gravitational potential," and essentially represents the "mean sea level." The geoid model is not an exact representation of sea level surface. Dynamic effects, such as waves and tides, are excluded in the geoid model.

b) Open GIS

- OpenGIS is the ability to share heterogeneous geodata and geoprocessing resources transparently in a networked environment

We should use open GIS for following:

1. Extends open system benefits to GIS.
2. Achieve inter-operability between system, data and functionality
3. Establish common language and unified model for geographic information

Benefits of OpenGIS

1. It allows integration with computing standards.
2. It provides quick and efficient development cycles.
3. It avoids data transfer redundancies.