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By

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1
UNIT

Photogrammetry

CONTENTS

PART-1

Introduction to Photogrammetry Principles and Types of Aerial Photographs.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 1.1. Define the photogrammetric survey. What are the types of photogrammetry ?

Answer

Photogrammetric Survey : It is the science and art of obtaining accurate measurements by use of photographs, for various purposes such as the construction of planimetric and topographic maps, classification of soils, interpretation of geology, acquisition of military intelligence and the preparation of composite pictures of the ground.

Types : Following are the two types of photogrammetry :

1. **Terrestrial Photogrammetry :** It is that branch of photogrammetry wherein photographs are taken from a fixed position on or near the ground.
2. **Aerial Photogrammetry :** It is that branch of photogrammetry wherein the photographs are taken by a camera mounted in an aircraft flying over the area.

Que 1.2. Explain the principle of photogrammetric survey.

Answer

Principle of Photogrammetric Survey :

1. Principle of photogrammetric survey in its simplest form is very similar to that of the plane table survey.
2. Only difference is that the most of the work which in plane table survey is executed in the field, in photogrammetry that is done in office.
3. The principal point of each photograph is used as a fixed station and rays are drawn to get points of intersections very similar to those used in plane table.
4. It is suitable for topographical or engineering surveys and also for those projects demanding higher accuracy.

5. It is unsuitable for dense forest and flat-sands due to the difficulty of identifying points upon the pair of photographs.

Que 1.3. Mention the different type of aerial photographs and explain each one of them.

OR

Explain the different types of photographs with diagrams.

Answer

Types : Following are the different types of photographs :

A. Terrestrial Photograph :

1. It is the photograph taken from ground station.
2. The instrument used is photo-theodolite which is a theodolite mounted on a camera with its axis horizontal or nearly horizontal.
3. The line of collimation of the telescope and the optical axis of the camera are parallel to each other.

B. Aerial Photograph :

1. These are the photographs taken from overhead position with a camera board on an aeroplane, an artificial or natural satellite or a planet.
2. It can further be divided depending upon the angle between the axis of camera and the vertical axis as follows :

i. Vertical Photograph : It is a one, in which the optical axis of the camera is vertical or nearly vertical. A truly vertical photograph resembles a map, through a vertical photograph can be rarely obtained.

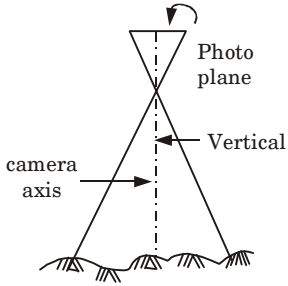


Fig. 1.3.1. Vertical photograph.

ii. Tilted Photograph : When the optical axis of the camera is unintentionally inclined to the vertical by not more than 3°, then the photograph taken is called "tilted photograph" as shown in Fig. 1.3.2.

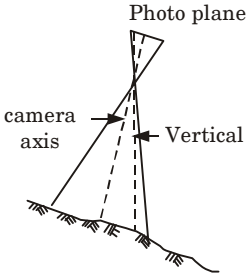
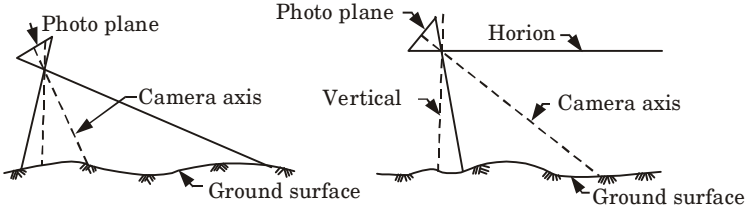


Fig. 1.3.2. Tilted photograph.

iii. Oblique Photograph : It is the photograph taken when the optical axis is intentionally inclined to the vertical at a greater angle. This is done to obtain a more familiar view of the terrain. Oblique photographs may further be divided into two categories :

a. Low Oblique Photographs : Photographs which do not show the horizon.

b. High Oblique Photographs : Photographs which show the horizon.



(*a*) Low-oblique photograph (*b*) High-oblique photograph

Fig. 1.3.3.

iv. Convergent Photographs :

a. These are low oblique photographs taken with two cameras exposed simultaneously at successive exposure stations.

b. The camera axis is tilted at a fixed inclination from the vertical in the direction of flight, so that forward exposure of the first station forms a stereopair with backward exposure of the next station.

v. Trimetrogon Photographs : These types of photographs are combination of vertical and low oblique photographs exposed simultaneously from the air station with two cameras.

Que 1.4. What is aerial photogrammetry ? Write advantages and disadvantages of aerial photogrammetry.

Answer

A. Aerial Photogrammetry : Refer Q. 1.1, Page 1–2H, Unit-1.

B. Advantages : Following are the advantages of aerial photogrammetry :

1. Suitable for inaccessible areas.
2. Suitable for mountainous region with less vegetation.
3. Suitable for mapping large areas, faster and economical.

C. Disadvantages : Following are the disadvantages of aerial photogrammetry :

1. Not suitable for dense forests and flat sands due to difficulty of identifying objects upon the photographs.
2. Not economical for survey of small areas.

Que 1.5. What do you understand by the term 'Aerial photography' ? Also write a short note on the factors that influence aerial photography.

Answer

A. Aerial Photography : Refer Q. 1.1, Page 1–2H, Unit-1.

B. Factors : Following are the factors that influence aerial photography :

1. **Atmospheric Conditions :** The presence of particles (smoke or dust) and molecules of gases in the atmosphere tends to reduce contrast because of scattering, therefore, the best time photography is when the sky is clear (November-February).
2. **Scale :** Ratio of f/h (f-focal length of the camera lens and h-flying height above the mean terrain). Due to variations in flying height, the scales of different photographs may vary. Scale may also vary because of the effects of tilt and relief displacements.
3. **Camera/Film/Filter Combination :** To ensure good image quality, modern distortion free cameras are used. Depending upon the requirements different lens/focal length/film/filter combinations can be used.
4. **Flight Direction :** Aerial photography is flown in strips to cover the designated area. It is advisable to keep the number of strips to minimum. The flight direction of strips is therefore kept along the length of the area.
5. **Time/Season of Photography :** Aerial photography should be flown when the sun's elevation is 30 degrees above the horizon or three hours before and after the local noon time.

Que 1.6. Differentiate between 'Aerial photography' and 'Aerial photogrammetry'.

Answer

S. No.	Aerial Photography	Aerial Photogrammetry
1.	Aerial photography is the art of taking and processing photographs.	Aerial photogrammetry is the science of making measurements from photographs.
2.	The fundamental principle used by photography is line of sight.	The fundamental principle used by photogrammetry is triangulation.

PART-2

Geometry of Vertical and Aerial Photograph, Scale and height Measurement on Single and Vertical Aerial Photograph.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 1.7. Define various basic terms associated with aerial photography.

Answer

Following are the basic terms associated with aerial photography :

1. **Exposure Station (or Air Station) :** It is the position of the aircraft (essentially the optical centre of the camera lens) at the instant of exposure of the film.
2. **Flying Height :** It is the elevation of the exposure station above the datum.
3. **Altitude :** It is the height of the exposure station above the Earth's surface.
4. **Line of Flight :** It is the track along which the aircraft flies.
5. **Perspective Center :** It is the real or imaginary point at which all the rays of light converge at or diverge from. Obviously it is the optical centre of the lens.
6. **Principal Point :**

i. It is a point on the photo where a perpendicular from the front nodal point of the camera lens strikes the photographic plane. On photo it is called 'photo principal point' (p). It is considered to be the origin of photo co-ordinate system.

ii. When this perpendicular is extended downwards, the point of intersection with the ground is called ground principal point (p').

7. Nadir Point (or Plumb Point) : The point, where the plumb line *i.e.*, line of gravity from the optical centre of the camera strikes the photograph, is called the photo nadir point (v) and where it strikes the ground, the ground nadir point (V).

8. Principal Plane : The plane passing through O, V and P is called principal plane. It is the plane constituted by the line of flight and the vertical.

9. Principal Line : It is the line of intersection of the principal plane with the photographic plane. Thus it is the line obtained by joining the principal point and the nadir point on the photograph.

10. Tilt : It is the angle which the optical axis of the camera makes with the vertical *i.e.*, the angle *VOP* in the Fig. 1.7.1. It is denoted by t.

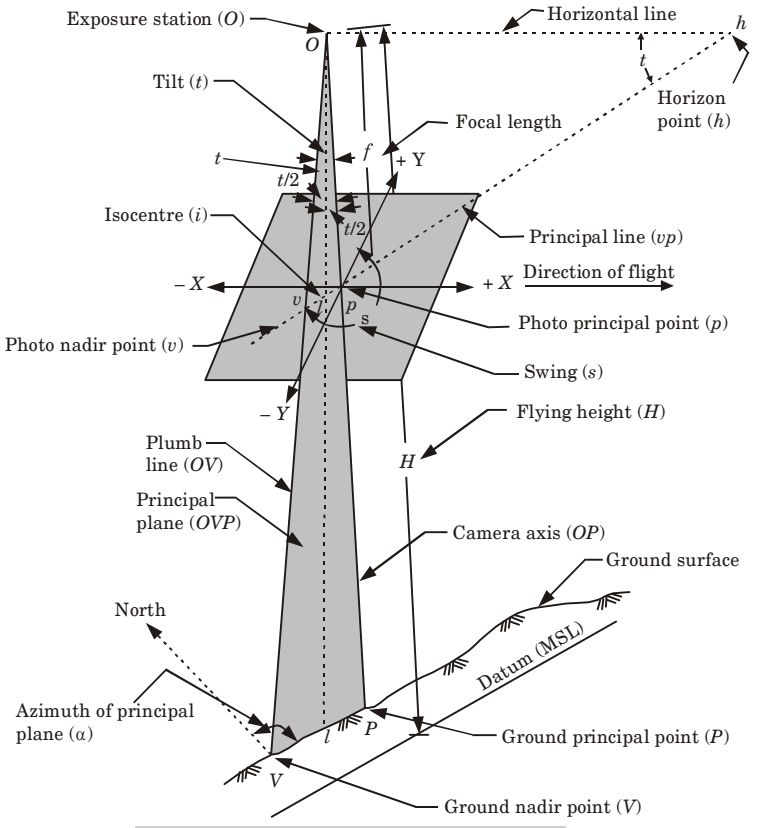


Fig. 1.7.1. Definitions of technical terms.

11. Isocentre (i) :

i. It is the point on the photograph at which the bisector of the angle of tilt meets the photographic plane.

ii. It lies midway between v and p on the principal line. $vi = ip = f \tan t/2$ where f is the focal length of the camera lens.

iii. In a truly vertical photograph $t = 0°$, therefore i, v and p all coincide.

12. Tip : It is the inclination of the camera axis about a horizontal axis perpendicular to the line of flight.

13. Homologous Points : These are the pair of points representing ground points and their photo points.

14. Swing : It is the horizontal angle measured clockwise in the plane of the photograph from the positive direction of Y-axis to the photo nadir point.

15. Azimuth of the Principal Plane (α) : It is the horizontal angle measured in clockwise direction from north meridian to the principal plane. It is also called "Azimuth of the Photograph".

16 Horizon Point (h) : It is the point of intersection of principal line (vp) produced with horizontal line through the exposure station.

17 Air-base : It is the distance between two successive exposures along a flight line.

Que 1.8. How will you determine the scale of an aerial photograph ? What do you understand by the terms 'datum scale' and 'average scale' ?

OR

Derive an expression for the scale of vertical photograph.

Answer

A. Scale of Aerial Photograph :

1. Scale of a vertical photograph = $\dfrac{\text{Distance on photo}}{\text{Corresponding distance on ground}}$

2. In the case of a map, the scale is uniform for the entire map because a map is an orthographic projection, whereas in case of a photograph the scale varies due to variation in elevation of a terrain because a photograph is a perspective projection.

i. Flat Terrain : The Fig. 1.8.1 shows a flat terrain AB height h above datum.

$$\text{Scale, } S = \frac{ab}{AB}$$

From similar triangles Oap and OAP,

$$\frac{ab/2}{AB/2} = \frac{Op}{OP}$$

$$\frac{ab}{AB} = \frac{Op}{OP} = \frac{f}{H'} = \frac{f}{H-h}$$

$$S = \frac{f}{H-h}$$

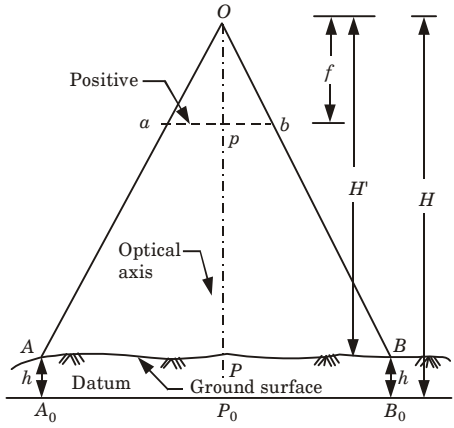


Fig. 1.8.1. A vertical photograph taken over flat terrian.

ii. Variable Terrain : Fig. 1.8.2 shows the vertical photograph of a terrain, in which the elevation is not constant. As per formula $S = \frac{f}{H-h}$, the scale increases with increase in elevation. Consider two points A and B, h_A and h_B above datum respectively.

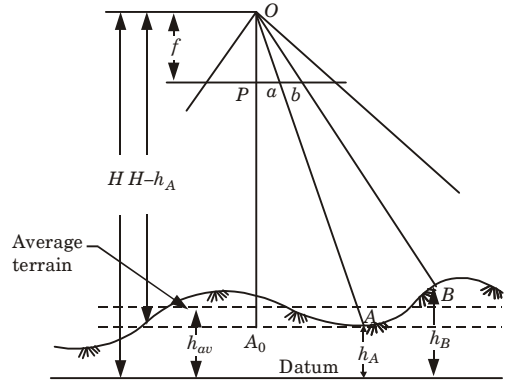


Fig. 1.8.2. Vertical photograph taken over variable terrain.

$$S_A = \frac{f}{H-h_A}$$

and, $$S_B = \frac{f}{H - h_B}$$

B. Average Scale :

1. For a variable terrain it is often convenient to express average scale of the photograph. If elevation of points *A, B, C, D*..... is h_A, h_B, h_C, h_D ....

then, $$h_{av} = \frac{1}{n}\ (h_A + h_B + h_C + h_D + ...)$$

$$S_{av} = \frac{f}{H - h_{av}}$$

2. Average scale of a terrain can also be obtained by determining scale of different points and taking their average.

$$S_{av} = \frac{1}{n}\ (S_A + S_B + S_C + S_D + ...)$$

C. Datum Scale (S_D) :

1. The datum scale of a vertical photograph is the scale that would be, if all the ground points were projected downwards on the datum.

2. From Fig. 1.8.1, $$S_D = \frac{ap}{A_0P_0} = \frac{f}{H}$$

Que 1.9. Discuss the method of determination of ground coordinates and distance between two points on ground.

OR

Derive an expression for the scale of a vertical photograph. Explain how the ground coordinates and the distances can be obtained from a vertical photograph.

Answer

A. Scale of Vertical Photograph : Refer Q. 1.8, Page 1–8H, Unit-1.

B. Co-ordinate and Distances of Vertical Photograph :

1. Let photo co-ordinates of a point be (x, y) and ground co-ordinates of corresponding point (X, Y) then from scale of a photograph,

$$S = \frac{x}{X} = \frac{f}{H - h}$$

where, H = Flying height.
h = Elevation of the point.

Then, $$X = x\,\frac{H - h}{f} = \frac{x}{S}$$

2. If there are two points A and B on the ground with elevations h_A and h_B then their ground co-ordinates are :

$$X_A = x_A\,\frac{H - h_A}{f} = \frac{x_A}{S_A} \text{ and } Y_A = y_A\,\frac{H - h_A}{f} = \frac{y_A}{S_A}$$

$$X_B = x_B \frac{H - h_B}{f} = \frac{x_B}{S_B} \text{ and } Y_B = y_B \frac{H - h_B}{f} = \frac{y_B}{S_B}$$

3. Distance between two points by co-ordinate geometry,

$$D = \sqrt{(X_A - X_B)^2 + (Y_A - Y_B)^2}$$

PART-3

Height Measurement based on Relief Displacement.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 1.10. **Explain relief displacement on a vertical photograph. Derive an expression for its determination. Also derive an expression for determining scale of a vertical photograph.**

OR

Explain, what is relief displacement and how is it calculated ?

OR

Define relief. Derive an expression for the displacement due to ground relief.

Answer

A. Relief Displacement :

1. Relief displacement occurs when the point being photographed is not at an elevation of the mean datum.
2. The distance on a photograph, from the image of any ground point to its fictitious image projected to a datum plane is the image displacement caused by topographic relief and is known as relief displacement.

B. Derivation :

1. Fig. 1.10.1 shows a vertical photograph taken from a height H above datum.
2. The image of ground point A_0, whose elevation is h_1, is 'a_0' on the photograph and that of its projection on the datum plane A_1 is a_1, thus aa_1 is the relief displacement of point A due to its elevation h_1. Similarly the relief displacement of point A_2 is aa_2 on the photograph.
3. Let,
   r_0 = Radial distance of 'a_0' from principal point 'p'.
   r_1 = Radial distance of 'a_1' from principal point 'p'.
   r_2 = Radial distance of 'a_2' from principal point 'p'.
   R = Ground distance A_0P_0.

4. From similar triangles a_1pO and A_1P_1O, we get

$$\frac{f}{H} = \frac{r_1}{R}$$

$$fR = r_1H \quad ...(1.10.1)$$

5. From similar triangles $a_0\,pO$ and A_0P_0O, we get

$$\frac{f}{H-h_1} = \frac{r_0}{R}$$

$$fR = r_0\,(H-h_1) \quad ...(1.10.2)$$

6. From eq. (1.10.1) and eq. (1.10.2), we get

$$+r_1H = r_0(H-h_1) \quad ...(1.10.3)$$

or

$$r_0 = \frac{r_1H}{H-h_1} \quad ...(1.10.4)$$

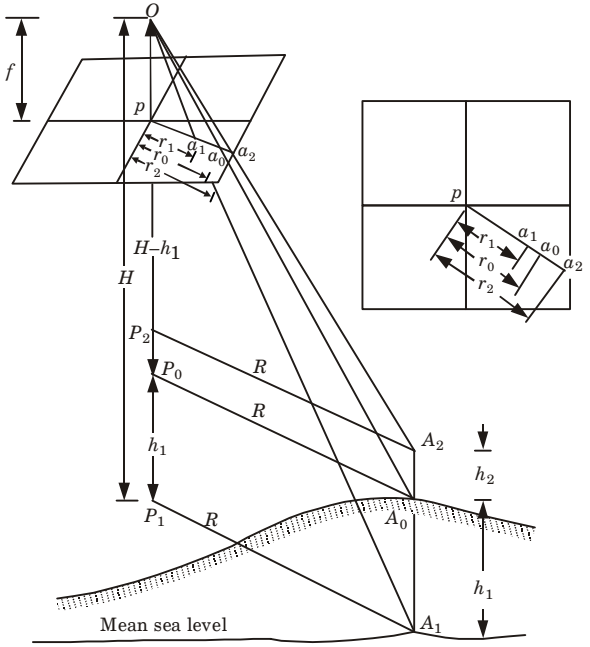


Fig. 1.10.1. Topographic relief displacement.

7. Relief displacement of ground point A_0,

$$d = aa_1$$

$$d = pa_0 - pa_1 = r_0 - r_1$$

$$= r_1\left(\frac{H}{H-h_1}\right) - r_1 = r_1\left[\frac{H}{H-h_1} - 1\right] = \frac{r_1h_1}{H-h_1} \quad ...(1.10.5)$$

8. From similar triangles a_2pO and A_2P_2O, we get

$$\frac{f}{H - h_1 - h_2} = \frac{r_2}{R}$$

$$fR = r_2 (H - h_1 - h_2) \quad ...(1.10.6)$$

9. From eq. (1.10.2) and eq. (1.10.6), we get

$$fR = r_0(H - h_1) = r_2(H - h_1 - h_2)$$

$$r_0 = r_2 \frac{H - h_1 - h_2}{H - h_1} \quad ...(1.10.7)$$

10. Relief displacement of point A_2,

$$d = r_2 - r_0 = r_2 - r_2 \frac{H - h_1 - h_2}{H - h_1}$$

$$= r_2 \left[1 - \frac{H - h_1 - h_2}{H - h_1}\right] = \frac{r_2 h_2}{H - h_1} \quad ...(1.10.8)$$

Que 1.11. How do you determine the height of object from relief displacement ?

Answer

1. If the scale of the photograph is known, the height of any object, such as a tower *TB* shown in Fig. 1.11.1 can be determined by following equation :

$$d = \frac{rh}{H} \quad ...(1.11.1)$$

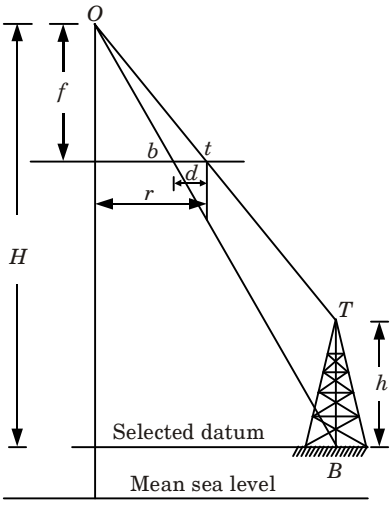


Fig. 1.11.1. Height of a tower from relief displacement.

2. Let h be the height of the tower above its exposure station above the selected datum passing through the base of the tower.
3. Let t and b be the top and bottom positions of the tower on the photograph.
4. The radial distance r and the relief displacement can very easily be measured.
5. If the scale S of the photograph is known, the height H can be calculated from the relation

$$S = \frac{f}{H} \qquad ...(1.11.2)$$

6. Knowing H, and measuring d and r, the height h is calculated from eq. (1.11.1). Thus,

$$h = \frac{dH}{r} \qquad ...(1.11.3)$$

where, h is the height of the tower above the selected datum with reference to which H has been computed.

7. Incidentally, if the elevation of the bottom of the tower is known, the height of flight above mean sea level can be known.

Que 1.12. The distance from the principal point to an image on a photograph is 6.44 cm and the elevation of the object above datum is 250 m, what is the relief displacement of the point is datum is 1/10000 and focal length is 20 cm.

Answer

Given : Elevation of the object, $h_1 = 250$ m
Distance between principal point to image on photograph, $r_1 = 6.44$ cm
Scale, $S = 1 : 10{,}000$, Focal length, $f = 20$ cm
To Find : Relief displacement.

1. Scale of photograph is given by,

$$S = \frac{1}{10{,}000} = \frac{f}{H} = \frac{20/100}{H}$$

or $$H = \frac{20}{100} \times 10{,}000 = 2{,}000 \text{ m above datum.}$$

2. $$\text{Relief displacement} = \frac{r_1 h_1}{H - h_1} = \frac{6.44 \times 250}{2000 - 250} = 0.92 \text{ cm}$$

PART-4

Fundamental of Stereoscopy, Fiducial Points, Parallax Measurement Using Fiducial Line.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 1.13. Describe the stereoscope with its functions and types.

OR

Describe the mirror stereoscope with neat sketch.

Answer

A. Stereoscope : It is an instrument used for viewing stereopair in photogrammetric surveying or aerial surveying is called as stereoscope.

B. Function of Stereoscope :

1. A stereoscope is used to accommodate the wide separation of the individual photograph of the stereopair to the fixed length of the eye base.
2. It is also used to magnify the depth of perception.

C. Types of Stereoscope :

Following are the types of stereoscope which are generally used into practice of aerial surveying :

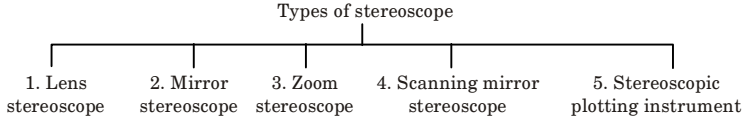


Fig. 1.13.1.

1. Lens Stereoscope :

i. This type of stereoscope consists of magnifying lens at a place of mirror for each eye.

ii. In case of lens stereoscope, the two lenses are mounted on an assembly in such way that distance between them is equal to the average eye base or interpupillary distance of the human eye. However minor adjustment is done for the separation of these two lenses according to the user.

iii. The distance between the nodal points of the lens and the photograph is always proportionate to the focal length of the lens being used in the stereoscope.

iv. Lens stereoscope causes more strain to the eyes but lens stereoscope is small in size and compact and hence can be conveniently handled and used in the field of aerial survey.

v. Since lenses have the magnifying effect, the heights of an object can be seen larger than the actual height of an object.

2. Mirror Stereoscope :

i. This type of stereoscope consists of four mirrors, two mirror say m_1 and m_2 are small eye piece mirror and other two say M_1 and M_2 are larger wing mirror as shown in Fig.1.13.2.

ii. These four mirrors are situated at an orientation of 45° with the plane of the photographs.

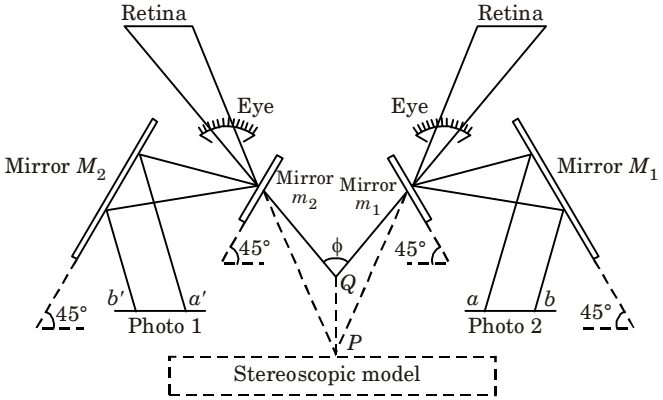


Fig. 1.13.2. Optical diagram of mirror stereoscope.

iii. The photographs to be viewed are placed at a certain distance from the wing mirror M_1 and M_2 and light reaches to the eyes exactly as it would come from the actual terrain.

iv. Mirror stereoscope completely separate the photographs for viewing and the whole overlap area can be seen stereoscopically without any slip of photographs, is the greatest advantages of mirror stereoscope.

v. It is not handy and portable due to its large size.

Que 1.14. Write a short note on fiducial points.

Answer

Fiducial Points or Mark :

1. Fiducial mark is a set of marks located in the corners or edge-centers, or both, of an aerial photographic image.
2. These marks are exposed within the camera onto the original film and are used to define the frame of reference for spatial measurements on aerial photographs.
3. Opposite fiducial marks connected, intersect at approximately the image center or principal point of the aerial photograph.
4. The principal point is the geometric center of the photograph. Typical positions of fiducial marks in an aerial photo are shown in Fig. 1.14.1.

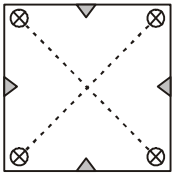


Fig 1.14.1. Illustration of the location of the fiducial marks and principal point for an aerial photo image. The intersection of the dotted line indicates the principle point.

Que 1.15. Describe the construction and working of a parallax bar with the help of a neat sketch.

OR

Describe the parallax bar with neat sketch.

Answer

A. Construction of Parallax Bar :

1. It is used to measure the parallax difference between two points. The difference in parallax of two points is called parallax difference.

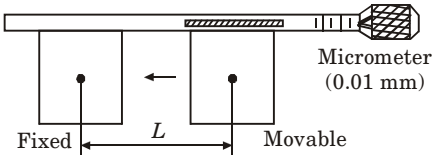


Fig. 1.15.1. Parallax bar.

2. Parallax is the displacement in the image of an object caused by a shift in the point of observation *i.e.*, successive exposures during a flight. It is also called stereoscopic parallax or *x*-parallax.

3. The instrument as shown in Fig. 1.15.1 consists of two plates of transparent materials attached to a bar.

4. The left plate is fixed and the right one movable with the help of a micrometer screw.

5. The total movement possible being 25 mm, which can be read nearest to 0.01 mm. Each plot contains a tiny dot in the centre.

6. The stereopair is viewed under a stereoscope and the parallax bar is placed on the photographs.

B. Working :

1. Let it be required to measure the parallax difference between two points A and C whose image appear on both the photographs at (a, c) and (a', c') respectively.

2. The left mark of the parallax bar is placed over a and the parallax bar is so oriented that it is parallel to the flight line.

3. Move the right mark and make the fused dot to touch the ground point. Take the micrometer reading.

4. Shift the bar bodily, put the left mark over the image c and move the right mark so that the fused marks again rests on the ground.

5. Note the micrometer reading. The difference between the two readings gives the value Δp.

6. Thus in Fig. 1.15.2 when point a is fused, the separation of the marks is lesser and the point is higher as is clear from the two intersecting rays OaA and $O'a'A$ in the lower part of the diagram.

7. Similarly, when c is fused, the separation of the marks is increased, and the point of lower as is clear from the two intersecting rays OcC and $O'c'C$.

8. The difference in elevation is then found by,

$$\Delta H = \frac{(H - h)^2 \, \Delta p}{(H - h)\Delta p + b_m \, H}$$

where, b_m is the mean principal base.

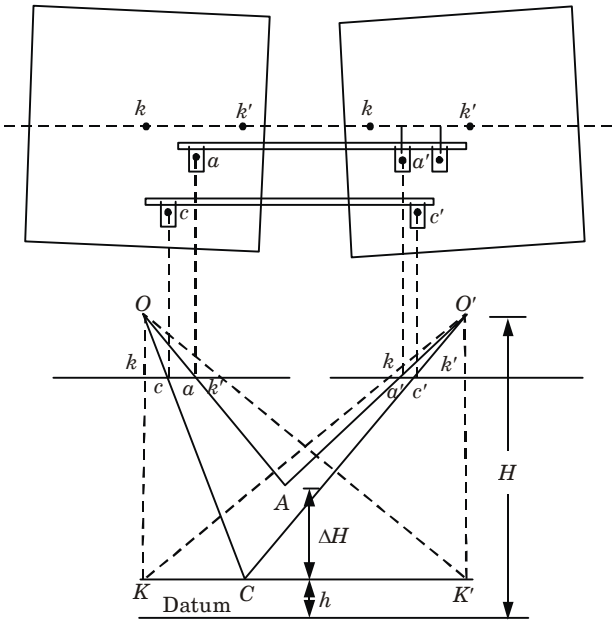


Fig. 1.15.2. Principle of a parallax bar.

Que 1.16. **Derive the parallax equation for determining the evaluation of a point.**

OR

Establish parallel equation for determining elevation of a point from a stereopair.

Answer

1. Fig. 1.16.1 shows the two images of a point A as a when the aircraft is at position O_1 and as a' when the aircraft is at O_2.
2. There is obviously a shift in the image because the image a is to the right of principal point whereas the image a' is to the left of principal point.
3. Co-ordinates of the point image a are (x_a, y_a) and that of a' are (x'_a, y'_a), while that of ground point A these are (X_A, Y_A).
4. From similar triangles O_1oa_y and $O_1A_oA_y$, we get

or $$\frac{Y_A}{H - h_A} = \frac{y_a}{f}$$

$$Y_A = \frac{y_a}{f}(H - h_A) \quad ...(1.16.1)$$

5. From the similar triangles O_1oa_x and $O_1A_oA_x$, yield

$$\frac{X_A}{H - h_A} = \frac{x_a}{f}$$

or $$X_A = \frac{x_a}{f}(H - h_A) \quad ...(1.16.2)$$

6. Also, from similar triangles $O_2o'a'_x$ and $O_2A'_oA_x$,

$$\frac{B - X_A}{H - h_A} = \frac{-x_a}{f}$$

or $$X_A = B + \frac{x'_a}{f}(H - h_A) \quad ...(1.16.3)$$

7. From eq. (1.16.2) and (1.16.3), we get

$$h_A = H - \frac{Bf}{x_a - x'_a} \quad ...(1.16.4)$$

8. Substituting P_a for $x - x'_a$ into eq. (1.16.4), we get

$$h_A = H - \frac{Bf}{P_a} \quad ...(1.16.5)$$

where, P_a = Parallax of the point A.

9. Now substituting eq. (1.16.5) into eq. (1.16.2) and eq. (1.16.1) and reducing, we get

$$X_A = B\frac{x_a}{P_a} \quad ...(1.16.6)$$

$$Y_A = B\frac{y_a}{P_a} \quad ...(1.16.7)$$

Eq. (1.16.5), eq. (1.16.6) and eq. (1.16.7) are commonly called parallax equations.

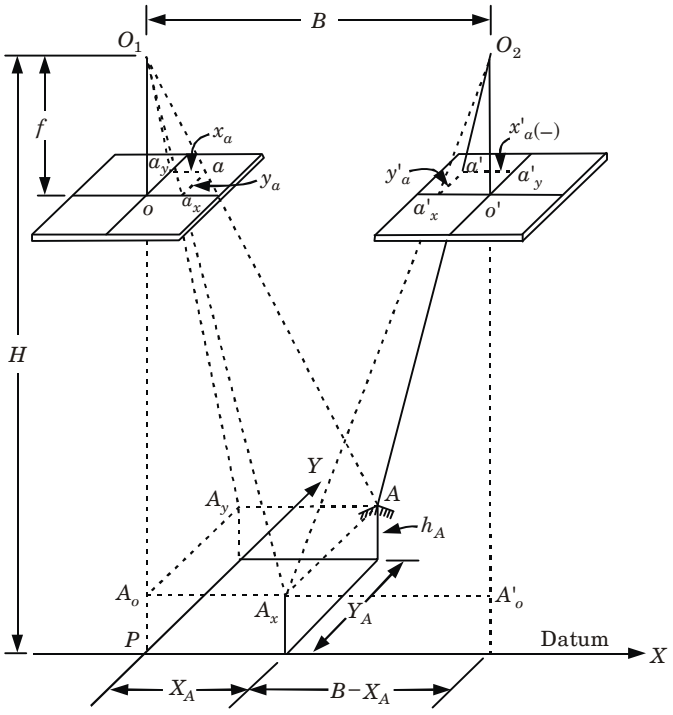


Fig. 1.16.1. Parallax relationship.

VERY IMPORTANT QUESTIONS

Following questions are very important. These questions may be asked in your SESSIONALS as well as UNIVERSITY EXAMINATION.

Q. 1. Define the photogrammetric survey. What are the types of photogrammetry ?

Ans. Refer Q. 1.1, Unit-1.

Q. 2. Explain the principle of photogrammetric survey.

Ans. Refer Q. 1.2, Unit-1.

Q. 3. What is aerial photogrammetry ? Write advantages and disadvantages of aerial photogrammetry.

Ans. Refer Q. 1.4, Unit-1.

Q. 4. Define various basic terms associated with aerial photography.

Ans. Refer Q. 1.7, Unit-1.

Q. 5. Explain relief displacement on a vertical photograph. Derive an expression for its determination. Also derive an expression for determining scale of a vertical photograph.

Ans. Refer Q. 1.10, Unit-1.

Q. 6. The distance from the principal point to an image on a photograph is 6.44 cm and the elevation of the object above datum is 250 m, what is the relief displacement of the point is datum is 1/10000 and focal length is 20 cm.

Ans. Refer Q. 1.12, Unit-1.

Q. 7. Describe the construction and working of a parallax bar with the help of a neat sketch.

Ans. Refer Q. 1.15, Unit-1.

2
UNIT

Remote Sensing

CONTENTS

PART-1

Remote Sensing basic / Remote Sensing Process, Concept and Foundation of Remote sensing Elements, Data Information, Remote Sensing Data Collection, Remote Sensing Advantages and Limitations.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 2.1. Define the remote sensing. What are the types of remote sensing ?

Answer

A. Remote Sensing : Remote sensing is the science and art of obtaining information about an object, area or phenomena, through the analysis of data, acquired by a device, that is not in contact with the object, area or phenomena under investigation.

B. Types : Following are the types of remote sensing :

1. Passive Remote Sensing :

i. In the case of passive remote sensing, source of energy is naturally available such as the sun.

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

iii. For all reflected energy, this can only take place during the time when the sun is illuminating the Earth.

iv. There is no reflected energy available from the sun at night.

v. Energy that is naturally emitted (such as thermal infrared) can be detected day or night, as long as the amount of energy is large enough to be recorded.

2. Active Remote Sensing :

i. In the case of active remote sensing, energy is generated and sent from remote sensing platform towards the targets.

ii. The sensor emits radiation which is directed toward the target to be investigated.

iii. The radiation reflected from that target is detected and measured by the sensor.

iv. Advantages for active sensors include the ability to obtain measurements anytime, regardless of the time of day or season.

v. Active sensors can be used for examining, wavelengths that are not sufficiently provided by the sun, such as microwaves, or to better control the way a target is illuminated. However, active systems require the generation of a fairly large amount of energy to adequately illuminate targets.

vi. Some examples of active sensors are a laser fluorosensor and synthetic aperture radar (SAR).

Que 2.2. **What are the essential elements of remote sensing system ?**

OR

Explain the general process involved in electromagnetic remote sensing.

Answer

A. Remote Sensing Process :

A remote sensing imaging system may be considered to be comprised of following elements as shown in Fig. 2.2.1.

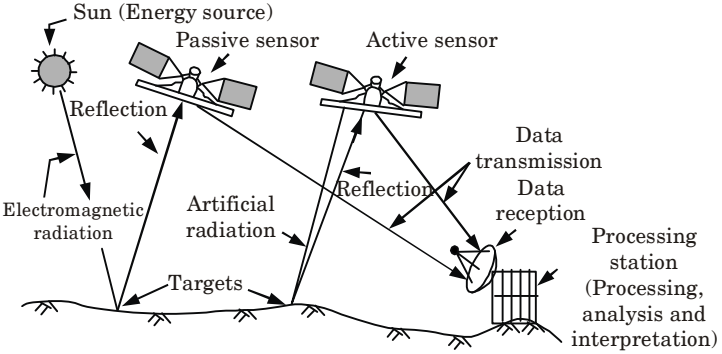


Fig. 2.2.1. Electromagnetic remote sensing process.

1. Energy Source or Illumination : An energy source that provides illumination or electromagnetic energy to the object of interest.

2. Radiation and the Atmosphere :

i. As the energy propagates from the source to the object, it will come in contact with the atmosphere it passes, and will interact with the atmosphere.

ii. The interaction will again take place while travelling back from object to the sensor.

iii. The atmospheric effects are caused through the mechanism of scattering and absorption.

3. Interaction with Earth Surface Features :

i. The energy will interact with the object depending upon the properties of the object and the radiation.

ii. The effects of the interaction of the incident energy with earth surface features may cause the energy to be reflected, transmitted, scattered, absorbed, and emitted.

4. Recording of Energy by the Sensor :

i. The scattered or emitted energy from the object is received, collected and recorded by the sensor.

ii. These are mounted on platforms, which are at a considerable height from the earth surface.

iii. The sensors may be passive or active.

5. Processing : The energy recorded by the sensor is transmitted in electronic form to a receiving and processing station where the data is processed into an image.

6. Interpretation and Analysis :

i. The processed image is interpreted visually and/ or digitally or electronically to extract information about the object which was illuminated.

ii. The information about the object extracted from the image helps to understand it better, reveal some new information, or assist in solving some new problem.

Que 2.3. Differentiate between active and passive remote sensing systems, under what condition each is preferable ?

Answer

Difference between Active and Passive Remote Sensing System :

S. No.	Active Remote Sensing System	Passive Remote Sensing System
1.	A system which utilizes manmade sources of energy for data collection is called an active system.	A system that uses an existing source of energy (e.g. sun ray) is called passive system.
2.	In this, system waves are propagated near the sensor and are bounced on the earth's surface to be recorded on their return.	It simple emitted and reflected radiation from ground surface when the energy source is independent of the recording instrument.
3.	In this system image of landscapes, derived from SLR or SLAR resemble aerial photographs with low angle solar illumination.	In this system without illumination from the sun, no photograph can be taken with a camera.

Que 2.4. Explain the methodologies of remote sensing data analysis.

Answer

1. Remote sensing is acquiring information about an object/phenomenon without coming in physical contact of it. Thus aerial photography is also remote sensing.
2. Aerial photographs are analyzed by finding co-ordinates of various features/ phenomenon, and their interpretation.
3. Stereopair photographs provide a better and three dimensional view of the area therefore keep in interpretation role of interpreter becomes vital.
4. In satellite images interaction of electromagnetic energy with matter (reflection, transmission, absorption, scattering) bring in changes in characteristics of incident energy.
5. Reflection is utmost important in these. These changes are recorded in satellite images.
6. The images received from satellites need to be corrected for atmospheric absorption and scattering.
7. Satellite images are analyzed based on spectral reflectance curves of various features/phenomenon available to arrive at what object/ phenomenon exists at any location.

Que 2.5. Describe the methods of collection of data.

Answer

A. Data Collection : The remote sensing image data is collected by aircraft, the spacecraft platforms, depending upon the sensors and the type of platforms (position of the camera).

B. Type of Methods for Collection of Data :

1. Photographic Method : Using camera and films (which are of various types).

2. Non-Photographic Method (Numerical): Using mechanical and electronic scanners.

i. Most of the remote sensing data are in digital format. Let us observe the steps used to generate the image.

a. **1st Step :** The detectors of the satellite detect the reflected energy or emitted energy from the earth surface.

b. **2nd Step :** The sensor system converts the reflected or emitted energy into analog electrical signal and convert it into the digital data.

ii. Incase of aircraft platform, the data arrives with the aircraft itself. In case of space-craft the data are tele-metered to the receiving stations.

As already mentioned the data generated by various sensors and through different plant forms are used by the people in-different fields, like, geology, agriculture, environment, regional planning etc.

iii. With the introduction of land sat satellite the remote sensing techniques have changed very drastically. Due to advanced techniques the remote sensing has become an important tool to make the up-to-date study of the surface of the Earth.

Que 2.6. Explain with the help of a neat sketch an idealized remote sensing system.

Answer

The ideal remote sensing system comprises of the following :

1. **A Uniform EM Energy Source :** It should provide energy of all wavelengths with uniform intensity at known high level of output irrespective of time and place.
2. **A Non-interfering Atmosphere :** EM energy should propagate through the atmosphere without loss on its way to or back from the target so that the energy does not get modified in the atmosphere. Ideally, it should hold irrespective of wavelength, time, place and sensing altitude.
3. **A Series of Unique Energy (Matter Interactions at the Earth's Surface) :** These interactions generate reflected and emitted signals that are selective with respect to wavelength, invariant and unique to each and every earth surface features type and sub-type of interest.
4. **A Super Sensor :**

i. The sensor (air borne or space borne) should be highly sensitive to all wavelengths and yield spatially detailed data on the absolute brightness (radiance) of the target as a function of wavelength.

ii. The super sensor would be simple, reliable, require virtually no power or space and be accurate and economical to operate.

5. **A Real Time Data Handling System :** The return signal from the target reaching a sensor is recorded and processed in real time (nearly instantaneously) by the data recorder. The data is then processed into a format useful for interpretation.
6. **Multiple Data Users :**

i. These people would have knowledge of great depth both of their respective disciplines and of remote sensing data acquisition and analysis techniques.

ii. The same set of data would become various forms of information for different users.

7. **Linear Sensor :** A sensor which responds linearly to EM energy of all wavelengths.

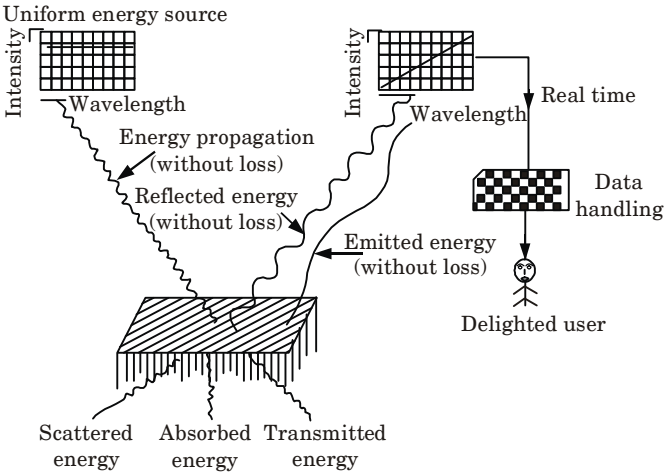


Fig. 2.6.1. Idealized remote sensing system.

Que 2.7. **How real remote sensing system differ from the ideal requirement ?**

Answer

S. No.	Aspect	Ideal Remote Sensing System	Real Remote Sensing System
1.	Energy source	It has uniform energy source, irrespective of time and place.	Energy varies with time, place and objects in ways that cannot be fully predicted.
2.	Atmosphere	It has non-interfering atmosphere that would neither absorb nor scatter electromagnetic energy.	It varies according to latitude, season, time of day, local weather etc.
3.	Spectral response	Each object would have a unique and known spectral response every where on earth surface.	In practical, these may change and cannot always be distinguished.
4.	Sensing system	Sensing system that would be highly sensitive through all wavelength of interest.	No existing sensing system can operate in all wavelength of interest.

Que 2.8. **Discuss the advantages and limitations of remote sensing.**

Answer

A. Advantages of Remote Sensing : Following are the advantages of remote sensing :

1. It gives a synoptic overview of the Earth's surface.
2. The data generated by remote sensing technique, is multi-spectral and have repetitive coverage.
3. It can collect the images and explain the intensity of the disaster and it aerial expansion.
4. This technique can help to collect the information in a little period of time.
5. The data generated by it can be used by multi-disciplines e.g., land use planning, forest development, geological surveys, urban planning, disaster management etc.

B. Limitations of Remote Sensing Techniques : Following are the limitations of remote sensing :

1. The aerial photographs and the satellite images do not have the facilities to correlate an aerial photograph with the ground.
2. It needs a skilled person to collect, to analyse and to map the data.
3. It also includes data processing to extract information for the direct input to Geographic Information System (GIS).

PART-2

Electromagnetic Spectrum, Energy Interaction with Atmosphere and with Earth Surface Features (Soil, Water and Vegetation).

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 2.9. **What do you understand by electromagnetic spectrum ?**

Answer

A. Electromagnetic Spectrum :

1. Visible light is the most obvious manifestation of EM radiation, other forms also exist.
2. EM radiation can be produced at a range of wavelengths and can be categorized according to its position into discrete region which is generally referred to electromagnetic spectrum.
3. Thus the electromagnetic spectrum is the continuum of energy that ranges from meters to nano-meters in wavelength travels at the speed of light and propagates through a vacuum like the outer space.
4. All matter radiates a range of electromagnetic energy, with the peak intensity shifting toward progressively shorter wavelength at an increasing temperature of the matter.

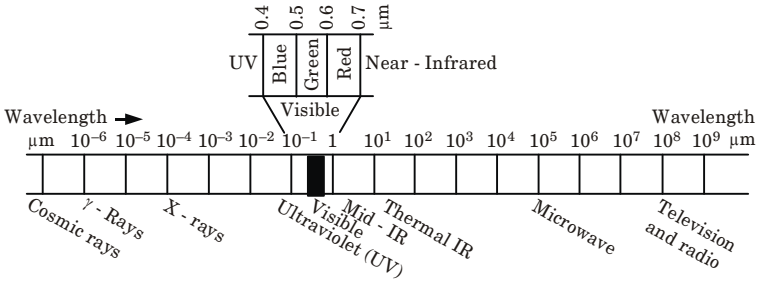


Fig. 2.9.1. Electromagnetic spectrum.

Que 2.10. Explain various interactions of incident EM energy with the atmosphere and Earth's surface.

Answer

A Energy Interaction with Atmosphere : The atmospheric effects are principally caused through the mechanism of atmospheric scattering and absorption.

1. Scattering :

i. Atmospheric scattering is the unpredictable diffusion of radiation caused by the molecules of the gases, dust and smoke in the atmosphere.

ii. Scattering is basically classified as selective and non-selective, depending upon the size of particles with which the electromagnetic radiation interacts.

2. Absorption :

i. A part of electromagnetic radiation is absorbed by the molecules of ozone, carbon dioxide and water vapours.

ii. The absorption of radiation occurs in specific wavelength intervals called absorption band and governs the regions of the spectrum to be used in remote sensing.

iii. Wavelengths shorter than 0.3 μm are completely absorbed by the ozone layer in the upper atmosphere which allows life on earth, a prolonged exposure to the intense energy of these wavelengths destroys living tissue.

iv. The aerosol-sized particles of liquid water in clouds absorb and scatter electromagnetic radiation at wavelengths less than about 0.3 μm.

v. Only radiations of microwave and longer wavelengths are capable of penetrating clouds without being scattered, reflected, or absorbed.

B. Energy Interaction with Earth Surface :

1. EM energy that strikes or encounters matter (object) is called incident radiation.

2. The EM radiation striking the surface may be (i) Reflected/Scattered, (ii) Absorbed, and/or (iii) Transmitted.

3. These processes are not mutually exclusive — EM radiations may be partially absorbed. Which processes actually occur depends on the following factors : (i) Wavelength of radiation, (ii) Angle of incidence, (iii) Surface roughness, and (iv) Condition and composition of surface material.

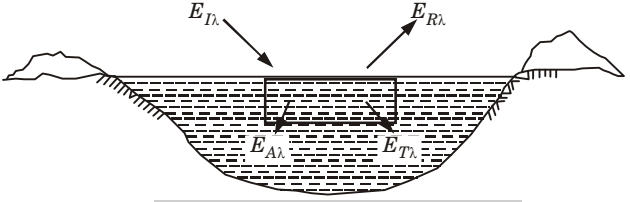


Fig. 2.10.1. Interaction mechanism.

where, $E_{I\lambda}$ = Incident EM energy.

$E_{R\lambda}$ = Reflected EM energy.

$E_{A\lambda}$ = Absorbed EM energy.

$E_{T\lambda}$ = Transmitted EM energy.

4. Interaction with matter can change the following properties of incident radiation :

i. Intensity.

ii. Direction.

iii. Wavelength.

iv. Polarization.

v. Phase.

Que 2.11. **Describe the EMR interaction with water, soil and vegetation.**

OR

Discuss on the spectral reflectance characteristics of water and vegetation in spectral band.

Answer

The EMR interaction with vegetation, soil and water is as follows :

A. Reflectance for Water :

1. Water has low reflectance at the most 10 % while vegetation may reflect up to 50 % and soil 30 – 40 %.
2. Water reflects in the visible and near IR range. Beyond 1.2 μm all energy is absorbed.
3. Turbid (silt laden) water has high reflectance.
4. Water containing plants with chlorophyll have peak reflectance in green wavelength.
5. Longer wave lengths of visible and near IR radiation is absorbed by water than shorter wavelengths therefore due to reflection of shorter wavelengths, water looks blue or blue green if viewed in visible band and darker if viewed in IR wavelengths due to no reflection.

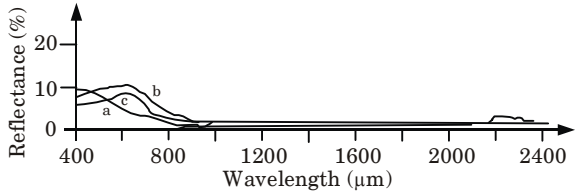


Fig. 2.11.1. Spectral reflectance curve of water.

6. Factors affecting variability of reflectance are depth of water, materials within water and surface roughness of water.

B. Reflectance for Soils : Factors affecting reflectance in soils are (1) moisture content, (2) particle size, (3) organic matter content, and (4) iron oxide content.

1. Moisture Content :

i. Soils have different proportions of sand, silt and clay (particle size 0.05 to 2.0 mm ϕ, 0.002 to 0.005 mm ϕ respectively). Large numbers of particles are present in clay compared to sand.

ii. When moisture is there in clay, each particle will be covered by a very thin layer of water; millions of such particles will hold a large amount of water. Thus particle size and moisture holding capacity of the soils are inter-related.

iii. Fig. 2.11.2 shows typical reflectance curves of study soils with different levels of moisture content. It shows that there are no absorption bands for dry sandy soils.

iv. Moist soils have less reflectance than dry soils (reflectance decreases with presence of water).

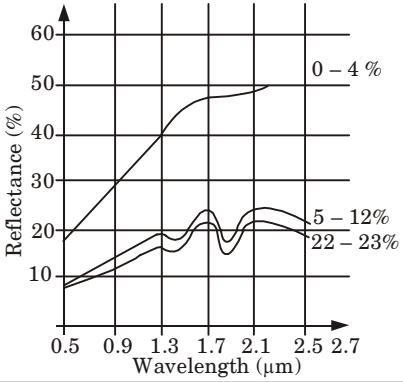


Fig. 2.11.2. Reflectance curves for a sandy soil at different levels.

2. Particle Size :

i. If particle size decreases, soil surface becomes smoother; more of the smoother energy is reflected.

ii. As particle size increases from 0.22 to 2.6 mm increase in absorption is 14 %.

3. Organic Matter :

i. It is an indication of amount and form of nitrogen in the soil organic content varies from 0.5 to 5 %.

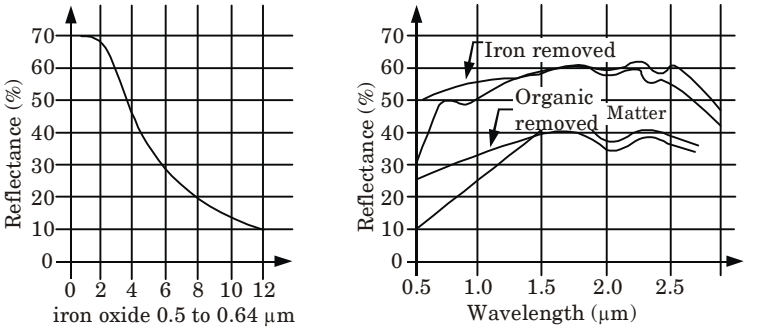
ii. A soil with 5 % organic matter appears dark brown or black in colour and with lower organic content light brown or light grey.

iii. Though this colour depiction with organic matter content changes with climatic and drainage conditions of the soil, which should also be considered.

4. Iron Oxide Content :

i. It can cause significant decrease in reflectance in the visible spectrum.

ii. Fig. 2.11.3 shows an excellent inverse relationship between reflectance % and iron oxide in visible region (0.5 to 0.64 μm).



(*a*) Reflectance of iron oxide (*b*) Influence of iron oxide and organic.

Fig. 2.11.3.

iii. Fig. 2.11.3 shows that removal of iron oxide causes a marked increase in reflectance from 0.5 to 1.1 μm and reflectance is insignificant beyond 1.1 μm.

iv. Removal of organic matter causes a similar marked increase in reflectance over the same wavelengths.

v. In general there is an increasing level of reflectance of dry soils with increase in wavelength.

C. Reflection for Vegetation :

1. Spectral reflectance curve of vegetation is distinctive.

2. Reflectance is low in blue and red regions of visible spectrum due to two chlorophyll absorption bands centered at 0.4 and 0.65 μm with reflectance peak at 0.5 μm. Chlorophyll absorbs radiation in red and blue wavelengths by reflection.

3. In near infrared region the reflectance is much increased beyond 0.7 μm to 1.3 μm wavelength region and is of the order of 40 – 50 % (absorption 5 %) with reflectance peaks in between.

4. The reflectance from multi-leaf layers is high compared to single leaf layer. With decrease in moisture content of the leaf, the reflectance increases.

5. In middle IR portion, there are water absorption bands at 1.4, 1.9 and 2.7 μm with reflectance peaks at 1.6 and 2.2 μm.

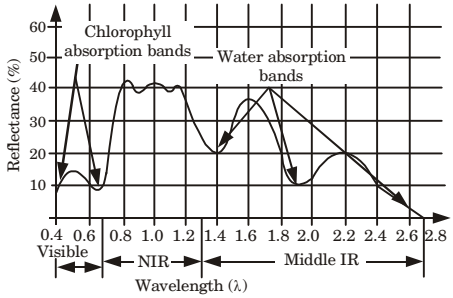


Fig. 2.11.4. Spectral reflectance curve of green vegetation.

6. Thus distinct spectral characteristics of green vegetation are :

i. There are distinct differences in the reflectance amongst visible, near IR and middle IR regions.

ii. In the visible portion pigmentation of leaves is the dominant absorbent.

iii. The internal leaf structure controls the reflectance in the near infrared where half is reflected and half transmitted.

iv. In the middle infrared, the total moisture content in the vegetation controls the reflectance where much of the incident energy is absorbed by the leaves. Green wavelengths leaves appear greenest to us in the summer when chlorophyll content is at its maximum.

v. In autumn, there is less chlorophyll in the leaves so there is less absorption and proportionality more reflection of red wavelengths making the leaves appear red or yellow.

PART-3

Indian Satellites and Sensors Characteristics, Map and Image False Color Composite, Introduction to Digital Data, Elements of Visual Interpretations Techniques.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 2.12. **Write characteristics of any one satellite with its sensor, band, swath, resolution, altitude and repeativity.**

Answer

A. IRS P6/Resourcesat-1 and Resourcesat-2 :

1. The IRS (Indian Remote Sensing) satellites form a large family of Earth observation satellites operated by the Indian space agency.
2. IRS P6/Resourcesat-1 and Resourcesat-2 ensure continuity of medium and high resolution data supply provided by the twin satellites IRS-1C and IRS-1D. These two, launched in 1995 and 1997 respectively, have completed their missions after more than 10 years of service.
3. Like their predecessors, Resourcesat satellites carry a LISS-III sensor as well as a wide field AWiFS sensor, but the high resolution (5.8 m) LISS-4 sensor replaces the panchromatic sensor.
4. The high resolution data are useful for applications such as urban planning and mapping, while the average resolution is used for vegetation discrimination, land mapping, and natural resources management.

i. Altitude : 816-818 km.

ii. Inclination : 98.6 degrees.

iii. Orbit: Sun-synchronous polar.

iv. Orbit Period (Repeativity) : 101 minutes.

v. Revisit Time : 5 days.

vi. Swath Width : 23.9 km – 70.3 km (LISS-IV) ; 140 km (LISS-III); 740 km (AWiFS).

vii. Satellites : IRS-P6/Resourcesat-1 (17/10/2003 – operational)

Resourcesat-2 (20/04/2011– operational).

B. LISS-III Sensor :

1. The LISS-III (Linear Imaging Self Scanning Sensor) sensor is an optical sensor working in four spectral bands (green, red, near infrared and short wave infrared). It covers a 141 km-wide swath with a resolution of 23 metres in all spectral bands.

Band	Spectral Band	Resolution
2	0.52 - 0.59 µm	23 × 23 m
3	0.62 - 0.68 µm	23 × 23 m
4	0.77 - 0.86 µm	23 × 23 m
5	1.55 - 1.70 µm	23 × 23 m

C. LISS-IV Sensor :

1. LISS-IV can work either in panchromatic or in multispectral mode with the same bands as LISS-III (except SWIR). However, the resolution is much better (5.8 m).
2. For Resourcesat-1, the swath width varies from 23.9 km in multispectral mode to 70.3 km in panchromatic mode.
3. For Resourcesat-2, the multispectral swath is enhanced to 70 km. The linear array sensor can be steered up to 26 degrees across-track, enabling stereoscopic imaging.

Mode	Spectral Band	Resolution
Panchromatic	0.50 - 0.75 μm	5.8 × 5.8 m

Mode	Band	Spectral Band	Resolution
Multispectral	2	0.52 - 0.59 μm	5.8 × 5.8 m
	3	0.62 - 0.68 μm	5.8 × 5.8 m
	4	0.77 - 0.86 μm	5.8 × 5.8 m

D. AWiFS Sensor :

AWiFS (Advanced Wide Field Sensor) is an optical sensor with intermediate spatial resolution.

Band	Spectral Band	Resolution
1	0.52 - 0.59 μm	56 × 56 m
2	0.62 - 0.68 μm	56 × 56 m
3	0.77 - 0.86 μm	56 × 56 m
4	1.55 - 1.70 μm	56 × 56 m

Que 2.13. Describe the false color composite of map and image.

Answer

False Color Composite (FCC) :

1. The remote-sensing images of a spectral band are on grey scale. However, it is more convenient to interpret various features on a colour image.

2. In case, the images generated by remote-sensing measurements in blue (0.4-0.5 μm), green (0.5-0.6 μm) and red (0.6-0.7 μm) bands are combined by superposing the transmission through blue, green, and red filters respectively, the resultant print/transparency is known as True Colour Composite.
3. In other words, for a true colour composite, an image obtained in blue, green and red spectral regions must be assigned blue, green and red colours to the image.
4. However, while displaying the different bands of a multispectral data set, images obtained in different bands are displayed in different colours, other than that of their own bands; the color composites obtained so are known as False Colour Composites (FCC).
5. By assigning colours complementary to the observation band, one could improve the visual perception and this is achieved in standard FCC by assigning blue, green and red colour to observations in green (0.52-0.59 μm), red (0.62-0.68 μm) and near infrared (0.77-0.86 μm) spectral bands respectively of IRS LISS sensors.
6. The vegetation normally reflects predominantly in near-IR region as compared to the green or red spectral band. Hence, vegetation appears red in standard FCC due to assignment of infrared band to red colour.
7. Agricultural land and forest would appear in pink to deep red depending on leaf greenness (as a green band has been assigned to the blue colour, the blue-red composition will lead to a pink colour.

Que 2.14. **Write a short note on digital image data.**

Answer

1. The digital image is made-up of discrete picture elements (pixel), each one of it has a digital number (DN) which is generated by the Electro-optical scanners of the satellite e.g., IRS, LANDSAT, SPOT etc.
2. In a digital image the data is arranged in a matrix of a number of pixels in a Line or Rows (i) and Columns (j). Each one of the pixel has a digital number it is also known as the brightness value and is located in x, y coordinate system.
3. A pixel can be defined as, "It a two dimensional picture element, which is the smallest non-divisible element of a digital image."

Processing of the Image :

1. The data set can be of multispectral bands and as mentioned above, each one of the pixel has a digital number or has the brightness value (Refer the Fig. 2.14.1), from each of these multispectral bands.

2. The digital number represents the variation in the intensity of energy which has been emitted, from the different features of the earth surface.
3. These digital numbers or the brightness values, start from 0 (zero) and goes upto a higher value on a grey scale e.g. In IRS series (7 bits data), these digital numbers vary from 0 to 127.
4. It is very simple to understand these values and their meanings e.g. lower the brightness value in the grey scale, lower the radiant energy emitted from that part of ground.
5. It varies between white represented by 127 digital or brightness value and Black represented by 0 digital or brightness value. (It means no energy has been emitted from that part of the ground, so the brightness is 0). It is in 7 bit data.

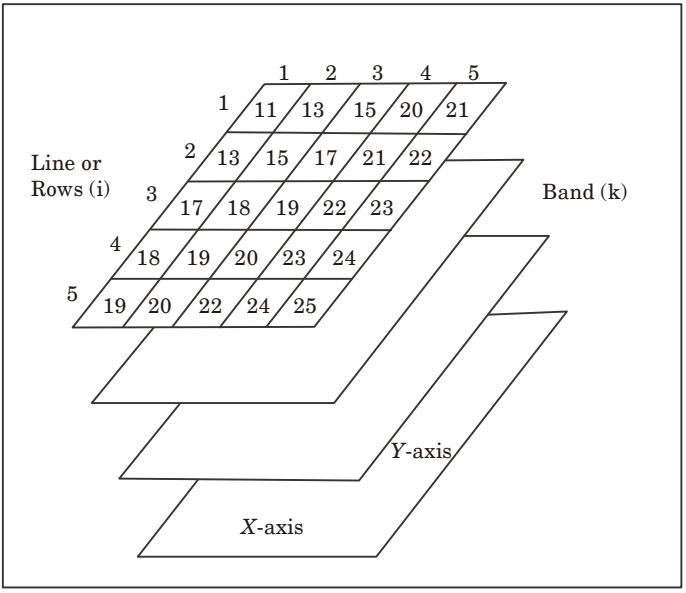


Fig. 2.14.1. A Digital Image located in x, y coordinate system.

6. In the raw image data, it possesses some distortions (known as noises), which create difficulties in demarcation of the features. To correct the problem of distortions, several image processing operations are required.

7. As the figure is represented by numbers, this image can be statistically processed by, (i) image addition, (ii) subtraction, (iii) multiplication and (iv) division, but this will not be possible in the hard copy representation of a satellite image.
8. So, the digital image is put in a computer and then through the different complex computer programmes (using equations), the image is computed statistically for each pixel and stores the output of the computation, as a new digital dataset.
9. Finally, this digital dataset is displayed in a pictorial form as a map or if required, is again processed through the computer.
10. Among all the image interpretation of elements digital image processing, only multispectral tone colours are used for interpretation.

Que 2.15. What are the elements of visual interpretations techniques ?

Answer

Elements of Visual Interpretation Technique :

Following are the elements of visual interpretation technique :

1. Location : There are two primary methods to obtain a precise location in the form of co-ordinates :

i. Survey in the field by using traditional surveying techniques or global positioning system instruments.

ii. Collect remotely sensed data of the object, rectify the image and then extract the desired coordinate information.

2. Size :

i. The size of an object is one of the most distinguishing characteristics and one of the more important elements of interpretation.

ii. Most commonly, length, width and perimeter are measured. To be able to do this successfully, it is necessary to know the scale of the photo.

iii. Measuring the size of an unknown object allows the interpreter to rule out possible alternatives. It has proved to be helpful to measure the size of a few well-known objects to give a comparison to the unknown-object.

iv. For example, field dimensions of major sports like soccer, football, and baseball are standard throughout the world. If objects like this are visible in the image, it is possible to determine the size of the unknown object by simply comparing the two.

3. Shape :

i. There are an infinite number of uniquely shaped natural and man-made objects in the world.

ii. A few examples of shape are the triangular shape of modern jet aircraft and the shape of a common single-family dwelling.

iii. Humans have modified the landscape in very interesting ways that has given shape to many objects, but nature also shapes the landscape in its own ways. In general, straight, rectilinear features in the environment are of human origin.

iv. Nature produces more subtle shapes.

4. Shadow :

i. Virtually all remotely sensed data are collected within 2 hours of solar noon to avoid extended shadows in the image or photo. This is because shadows can obscure other objects that could otherwise be identified.

ii. On the other hand, the shadow cast by an object act as a key for the identification of the object as the length of the shadow will be used to estimate the height of the object which is vital for the recognition of the object.

5. Tone and Colour :

i. Real-world materials like vegetation, water and bare soil reflect different proportions of energy in the blue, green, red, and infrared portions of the electro-magnetic spectrum.

ii. An interpreter can document the amount of energy reflected from each at specific wavelengths to create a spectral signature. These signatures can help to understand why certain objects appear as they do on black and white or colour imagery. These shades of gray are referred to as tone.

iii. The darker an object appears the less light it reflects. Colour imagery is often preferred because, as opposed to shades of gray, humans can detect thousands of different colours. Colour aids in the process of photo interpretation.

6. Texture :

i. This is defined as the "characteristic placement and arrangement of repetitions of tone or colour in an image."

ii. Adjectives often used to describe texture are smooth (uniform, homogeneous), intermediate, and rough (coarse, heterogeneous). It is important to remember that texture is a product of scale.

iii. On a large scale depiction, objects could appear to have an intermediate texture. But, as the scale becomes smaller, the texture could appear to be more uniform, or smooth.

iv. A few examples of texture could be the "smoothness" of a paved road, or the "coarseness" a pine forest.

7. Pattern :

i. Pattern is the spatial arrangement of objects in the landscape. The objects may be arranged randomly or systematically.

ii. They can be natural, as with a drainage pattern of a river, or man-made, as with the squares formed from the United States Public Land Survey System.

iii. Typical adjectives used in describing pattern are : random, systematic, circular, oval, linear, rectangular, and curvilinear to name a few.

8. Height and Depth :

i. Height and depth, also known as "elevation" and "bathymetry", is one of the most diagnostic elements of image interpretation.

ii. This is because any object, such as a building or an electric pole that rises above the local landscape will exhibit some sort of radial relief. Also, objects that exhibit this relief will cast a shadow that can also provide information as to its height or elevation. A good example of this would be buildings of any major city.

9. Site/Situation/Association :

i. Site has unique physical characteristics which might include elevation, slope, and type of surface cover (e.g., grass, forest, water, bare soil).

ii. Site can also have socioeconomic characteristics such as the value of land or the closeness to water.

iii. Situation refers to how the objects in the photo or image are organized and "situated" in respect to each other. Most power plants have materials and building associated in a fairly predictable manner.

iv. Association refers to the fact that when you find a certain activity within a photo or image, you usually encounter related or "associated" features or activities.

v. Site, situation, and association are rarely used independent of each other when analyzing an image.

vi. An example of this would be a large shopping mall. Usually there are multiple large buildings, massive parking lots, and it is usually located near a major road or intersection.

Que 2.16. **What are the advantages and disadvantages of visual interpretation of remote sensing ?**

Answer

Advantages of Visual Interpretation :

1. Simple method.
2. Inexpensive equipment.
3. Uses brightness and spatial content of the image.
4. Subjective and qualitative.
5. Concrete.

Disadvantages of Visual Interpretation :

1. Unfamiliar scale and resolutions.
2. Lack of understanding of physics of remote sensing.
3. Understanding proper spectral character of each object.
4. Visually interpret 3 layers of information at a time.

VERY IMPORTANT QUESTIONS

Following questions are very important. These questions may be asked in your SESSIONALS as well as UNIVERSITY EXAMINATION.

Q. 1. Define the remote sensing. What are the types of remote sensing ?

Ans. Refer Q. 2.1, Unit-2.

Q. 2. Differentiate between active and passive remote sensing systems, under what condition each is preferable ?

Ans. Refer Q. 2.2, Unit-2.

Q. 3. Describe the methods of collection of data.

Ans. Refer Q. 2.5, Unit-2.

Q. 4. How real remote sensing system differ from the ideal requirement ?

Ans. Refer Q. 2.7, Unit-2.

Q. 5. What do you understand by electromagnetic spectrum ?

Ans. Refer Q. 2.9, Unit-2.

Q. 6. Describe the EMR interaction with water, soil and vegetation.

Ans. Refer Q. 2.11, Unit-2.

Q. 7. Write a short note on digital image data.

Ans. Refer Q. 2.14, Unit-2.

3
UNIT

Geographic Information System (GIS)

CONTENTS

PART-1

Geographic Information System : Introduction to GIS, Components of GIS.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 3.1. Define the Geographical Information System (GIS).

Answer

A. GIS :

1. GIS stands for Geographical Information System. It consists of three disciplines, geography + information + system, geography is about Earth's various surface features (physical, biological and cultural) and information amongst them spatially referenced *i.e.*, denoted by a co-ordinate system, latitudes, longitudes.
2. System implies that a GIS is made up of several interrelated and mutually linked components with different functions. These parts operate individually and interact with one another as per procedures.
3. It can be considered to be made up of input, processing and output sub-systems.

B. Definitions of GIS : Several definitions of GIS have been given by different agencies, of which two are as follows :

1. According to Rhind (1989) : GIS is a system of hardware, software, and procedures designed to support the capture management, manipulation, analysis, modeling and display of spatially referenced data for solving complex planning and management problems.

2. According to United State Geological Survey (1997) : GIS is a computer based system capable of assembling, sorting, manipulating and displaying geographically referenced information *i.e.*, data identified according to their location. In simplest form, GIS is a computer aided system for storing, managing, manipulating geographical data to solve spatial problems of real world.

Que 3.2. Define GIS and its components.

Answer

A. GIS : Refer Q. 3.1, Page 3–2H, Unit-3.

B. Components : Following are the components of GIS :

1. Hardware :

i. It is computer hardware on which GIS software runs.

ii It consists :

a. Input devices e.g., digitizer, scanner and GPS.

b. Storage devices e.g., magnetic tapes, CD, DVD, CD ROMs.

c. CPU : Depending on the data processing power of CPU, computers are classified as super computers, main frame, mini computers, work sections, micro-computers and personal computers.

d. Output devices e.g., display devices, printers, plotters.

2. Software :

i. These are programmes which run on the computers.

ii. These programmes provide functions and tools to store, analyze and display geographic information.

3. Data :

i. Data in GIS is geospatial data. The sources of spatial data are digitized maps, satellite images, aerial photographs, statistical tables etc.

ii. Geographical and related attribute data can also be collected by surveying.

iii. Digital map forms are basic data input for GIS to which is attached tabular (attribute) data.

iv. Database is the foundation of a GIS, and is as good as the data it uses.

v. GIS integrates spatial and attribute data.

4. Procedure :

i. Procedures designed to support the data capture, storage, processing, analysis, modeling and display of geospatial data is important for a GIS.

ii. The interest and willingness of the organization setup and decision makers is important for using the results for planning and implementations.

5. Users : The roles of users are to select pertinent (useful) information to set necessary standards, to design cost efficient updating schemes to analyze GIS outputs for relevant purposes and plan the implementation. No GIS exists in isolation of the user.

Que 3.3. List important functions of GIS and explain any one in detail.

Answer

A. Function : Following are the various functions of GIS :

1. Buffering.
2. Reclassification.
3. Overlay analysis.
4. Proximity analysis.
5. Filtering.

1. Buffering :

i. It is the creation of a zone of interest around an entity.

ii. It is possible both in vector and raster data format.

iii. In vectors case, the result is a new set of objects.

iv. Buffers are very useful for analyzing landscapes, highway alignments water supply networks and drainage studies.

v. Buffering is very simple but involves complex computational operation.

vi. If a point is buffered, a circular zone is created. Buffering lines and areas creates new areas.

vii. Creating buffer zones around point features is the easiest operation; a circle of required radius is simply drawn around each point.

viii. Some GIS do this by placing a circle of required radius at one end of the line or area boundary to be buffered. This circle is then moved along the length of the segment.

ix. Sometimes there may be a need for another buffer around a buffer. This is called doughnut buffer.

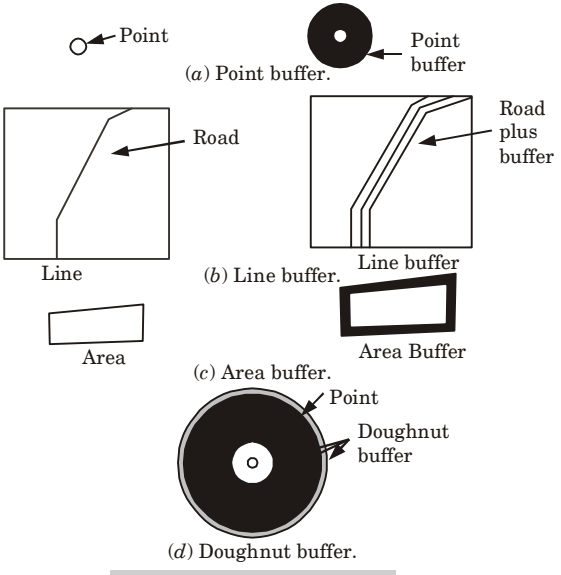


Fig. 3.3.1. Types of buffers.

PART-2

Geospatial Data : Spatial Data, Attribute Data , Joining Spatial and Attribute Data.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 3.4. What do you understand by spatial data ? How is the spatial relationship represented ?

Answer

A. Spatial Data :

1. It is also called geographical data, it consists of natural and cultural features that can be shown with lines or symbols on maps, or that can be seen as images on photographs.
2. The data in the different forms (maps, photographs, images, etc,) being in non-compatible formats create problems while integrating in GIS.
3. In a GIS, these data must be represented and spatially located in digital form, by using a combination of fundamental elements called simple spatial objects (SSO).
4. These SSO include points, lines and strings, areas or polygons, pixels, and grid cells.
5. SSO can be represented by their respective symbols.
6. The spatial data represented as either layers or objects are simplified by breaking down all geographic features with three basic entity types, points, lines and areas, before they can be stored in the computer.

B. Spatial Entities : The basic spatial entities are as follows :

1. Point :

i. Its requirement is for geographical reference to locate it with respect to other spatial entities.

ii. Point data consist of observations that occur only at points or occupy very small areas in relation to the scale of the database. These define single geometric positions as shown in Fig. 3.4.1(*a*).

2. Line and String :

i. It is ordered set of points (known as an arc, segment or chain) with defined start and end points (nodes) which also give the line direction.

ii. A line connects two points, and a string is a sequence of two or more lines as shown in Fig. 3.4.1(*b*).

3. Areal : It provides data about the points and lines used in construction of the area, and how these are connected to define the boundary. An area or polygon consists of a continuous space within three or more connected lines as shown in Fig. 3.4.1(*c*).

4. Pixels : These are usually tiny squares that represent the smallest elements into which a digital image is divided as shown in Fig. 3.4.1(*d*). Continuous array of pixels, arranged in rows and columns, are used to enter data from aerial photos, satellite images etc.

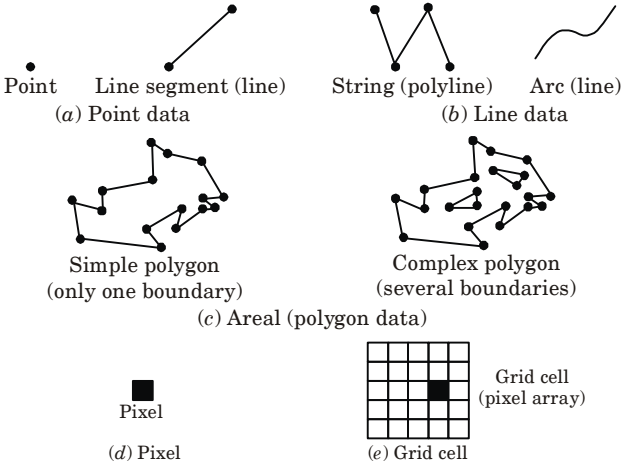


Fig. 3.4.1. Representation of entities.

5. Grid Cells : These are single elements, usually square, within a continuous geographic variable. Grid cells may be used to represent terrain slopes, soil types, land cover etc., as shown in Fig. 3.4.1(*e*).

C. Relationship :

1. Spatial relationships are connections between spatial objects when geometric properties are considered.
2. Three types of spatial relationships have been recognized, *i.e.*, topological, metric and ordinal.

3. Here, topological relationships are those that do not change under topological transformation, e.g., the connectivity of two objects, metric relationships are those described by measures of a metric space, and distances and angles are of those relations, ordinal relationships are represented by relative orders between objects, which are often described by prepositions such as before and behind.
4. These three types of spatial relationships are perhaps major ones, but unfortunately, they are not comprehensive.

Que 3.5. **What things can be represented by point, line and polygon ? Explain topological data model to represent area.**

Answer

A. Point :

1. Depiction by point depends on scale of the map. It is used to denote survey control points, a well are generally represented as point, which have negligible dimension.
2. A building, village, a city can be represented as point depend on scale of map.

B. Line : Lines are used to depict features which are primarily linear e.g., roadway, railway, river, canal, pipe lines, village boundary etc.

C. Polygon : Polygon is used to depict an area e.g., forest, cultivable land, fellow land, water body etc.

D. Topological Data Model : Topological data model is described the relations what exist in area features which are as follows :

1. Adjacency : These are areas which have a common boundary.

2. Containment : These are area features which may be wholly contained within another e.g., an island within a lake, district of a state.

3. Connectivity : It is used to describe linkage between linear features e.g., network of railways/roads.

Que 3.6. **Write a short note on non-spatial data.**

Answer

Non-Spatial Data :

1. The non-spatial data, also known as attribute data, are information about various attributes like length, area, population, acreage, etc.

2. Normally the spatial and non-spatial data are stored separately in a GIS, and links are established between the two at the time of processing and analysis.
3. The non-spatial data describe the attributes of a point, along a line, or in a polygon.
4. In other words they describe what is at a point (e.g., a hospital), along a line (e.g., a canal), or in a polygon (e.g., a forest).
5. The attributes of a soil category may be depth of soil, texture, type of erosion, permeability.
6. The non-spatial data, mostly available in tabular form, are also converted into digital format for use in GIS.

Que 3.7. **Write a short note on joining spatial and attribute data.**

Answer

Joining Spatial and Attribute Data :

1. After completing the data correction and merging operations, we join the spatial data with their corresponding attribute data.
2. Joining attribute data is begun by adding a common attribute shared by both spatial and attribute data.
3. GIS packages use the attribute data to identify spatial objects using their attributes.
4. In general, we use the identification number of spatial objects as their common attribute.
5. In addition to the identification number, other attributes, such as the address of houses and the name of house owners, can also be used as a common attribute.
6. However, since character attributes are more likely to have typographical errors, numerical attributes are more desirable.
7. The common attribute is the key to joining spatial and attribute data. A GIS package reads the identification number of the first spatial object, looks up this number in the attribute data, and then joins the attributes to the spatial object (if the same identification number exists).
8. Then, the GIS moves to the second spatial object and joins its attributes.
9. This procedure is repeated for all the spatial objects in the generation of the complete spatial data (Table 3.8.1).

Table 3.8.1. Joining attribute data.
(a) Spatial data; (b) Attribute data; and
(c) Spatial data joined with the attribute data.

Internal ID	ID defined by user	Owner's name	Floor size
(a) Spatial data :			
1	15		
2	14		
3	27		
4	11		
5	8		
(b) Attribute data :			
	15	Ankit	240.3
	14	Rustam	195.6
	27	Hareesh	212.4
	11	Vikas	200.7
	8	Nitendra	231.1
(c) Spatial data joined with attribute data :			
1	15	Ankit	240.3
2	14	Rustam	195.6
3	27	Hareesh	212.4
4	11	Vikas	200.7
5	8	Nitendra	231.1

PART-3

GIS Operations : Spatial Data Input, Attribute Data Management, Data Display, Data Exploration, Data Analysis.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 3.8. **Describe the data capture and input of GIS.**

Answer

Data Capture and Input of GIS :

1. The data of GIS is available in a number of forms and formats, so it can be captured by using a number of methods like photographic method,

numerical method, digital encoding method, pictorial labeled method, descriptive method, graphical colour coded method etc.

2. Two types of equipments are used to capture the GIS data :

i. Field data capture hardware.

ii. Computer data capture hardware.

i. Field Data Capture Hardware :

a. They are the simple electronic equipments.

b. They are portable and can be used easily by a single person, e.g., data loggers, GPS.

c. They are capable of collecting a large amount of data, they are cheap, light weighted, accurate and can be directly interfaced with the computer, through USB (universal serial bus) ports.

ii. Computer Data Capture Hardware :

a. The data collected by the two field equipments mentioned above, is in digital format.

b. But the data like maps, photographs, or images (analog data) such data may not be available in the digital format.

c. So it needs to be converted from the analog to digital format.

Que 3.9. **Describe the computer data capture hardware.**

Answer

Computer Data Capture Hardware :

1. The data collected by the field equipments is in digital format.

2. But the data like maps, photographs, or images (this type of data is known as analog data) such data may not be available in the digital format.

3. So it need to be converted from the analog to digital format. The conversion is performed by one of the two methods, such as

i. Digitizing

ii. Scanning

i. Digitising :

a. It is a process which is used to convert the hard copy map or an aerial photograph or an image, into a digital format, to be displayed on a computer screen. The equipment is known as digitizer.

b. It looks like a tracing table and have a flat, non-conducting surface into this, the cartesian grid of fine wires embedded. To this table or tablet a tracing pen is attached (or cursor or puck). A computer is necessary for viewing and recording the digital captured data.

c Any type of photograph or a map can be fixed to the surface of the digitizer. The user of the digitizer, select, an outline to follow with the cross-wire on the cursor.

d. When the line is followed, one of the buttons on the cursor is continuously clicked, to record the shape of the line. (The cursor may have upto 16 buttons). These buttons help other inputs or operations, like adding identifiers or for working in stream mode.

ii. Scanning :

a. It is another method used for converting the hardcopy map into a digital format, but unlike digitizing, in scanning, it captures all the information, on a given sheet, very quickly.

b. It is an ideal method to capture all the information from the map or a paper image, or to add information to the base map ; and for archiving existing maps.

c. In the big range of scanners, all of them use photosensitive pickup devices for registering different colours different gray shades, from the surface of the map, so they convert the analog image into the digital image. The data is stored as raster images because the pixel values that vary with the difference in the intensity of light.

d. Most of the scanners are capable of 8-bit resolution, or 256 brightness levels. The software converts the raster image into vector format for the further data entry.

e. Following are the important scanning devices, available in the market :

Flat-bed Scanners :

i. They have the photosensitive pickup that is mounted on a beam to allow the pickup to traverse the map, along the x-axis and the whole beam, then moves, slowly along a track, in the y-axis direction.

Drum Scanner :

i. The procedure of this scanner is same as that of the flat-bed scanner, but in this scanner, the map is mounted on a drum (as the name suggest).

ii. The drum then slowly revolves below the fixed track on which, the pickup rides in forward and backward directions, on x-axis.

Que 3.10. Describe the data processing of GIS.

Answer

Data Processing :

1. The computer itself is the data processing hardware. There are a lot computer processers, ranging from mainframes to mini-computers

and from work-station to micro or personal computers (PCs), and at present, from laptop computers to note book computers (palm top computers).

2. The first generation computers and so the processors were larger in size (and slower in working). At present, the sizes have and the prices have been reduced and the performance of the processors/ computers have gone up e.g. Today PC can perform like most of the workstations which are about five years old.
3. So, for GIS, mainframe would be replaced by work-station. Although, some of the complicated work and complex packages mainframe is still used.
4. Work-station is a logical choice. Most of them have a 32-bit architecture a large main memory and a large storage capacity, and high resolution graphics screen.
5. An average GIS work-station has the fallowing specifications :

i. A processing unit having 500 + MIPS (Million Instructions/per second)

ii. At least, 512 Megabyte Random Access Memory. (RAM.)

iii. 80 Giabytes of storage space on the internal hard disks.

iv. A communication device, with 100 megabits/per sec, transfer rate.

v. A high resolution work-station screen.

Que 3.11. Explain the data storage of GIS.

Answer

Data Storage of GIS :

1. It is necessary for the GIS to store a large volume of Data, together with the large primary memory, the secondary storage has become an important component of hardware.
2. This secondary storage has mainly two activities to carry which are as follows :

i. Storage of the computer programmes and datasets which consist of data that remains unchanged e.g. The read only material.

ii. Storage of data work which changes very frequently.

3. Generally 3.5 inch floppy disk and the computer's hard-disk drive is used as a media for storing data. The floppy disks have a limited storing capacity *i.e.*, 1.44 MB for a high density disk.
4. The hard drives for the PC, may range up to 40 Gigabyte to at least 80 GB. The storage capacity is used as a backup for the data.
5. A new external hard drive has extended the capacity of the computers. It is used to store the data separately from the main computer. In case of 'crash', this acts as the backup storage system.

6. The tape drives are used to store a large data. They are either in the form of magnetic tape cartridges or Red-to-Red drives.
7. The Digital Auto Tapes (DAT) and the video cartridges are very popular because of their higher capacities and also because of their Compactness.
8. As the magnetic tapes are to be kept away from the moisture and list. Their physical storage has become difficult and so they are cheap, their use has been reduced.
9. To have access to a large volume of data another storage medium is used. It is called as compact disks-read only memory (CD-ROM).
10. The CDs are optical disks which use laser technology, and have a huge capacity to store data e.g., a CD can store data up to 700 Megabytes.
11. They are easy to archive and transport less in cost. They can be written to can be edited and can be re-written.

Que 3.12. How the data display is carried out ?

Answer

1. Among all, the visualization of a map or an image, is the most important aspect of GIS application.
2. The other functions of GIS like data capturing, processing and storage become useless and meaningless, if the function of visualization is available for the users, to take the decisions.
3. Many data display devices are available in the market, they are available as the generic devices and the specific devices for GIS.
4. Following are some of the important display devices.

i. Video Display Unit : The VDU is also known as the computer screen or monitor.

Together with the development in computer technology the Cathode Ray Tube (CRT) based monitors also are having a fast development like.

a. For most of the PC screens high resolution displays with a dot pitch of greater than 0.28 mm are available.

b. They give the standard resolution of 1024 horizontal dots in 768 vertical lines.

c. With the larger screens on the work-stations now there may 1600 × 1280 screen dot image.

d. The screens have Non-interlaced scanning. This gives a flicker free display.

e. The screens have low-radiation, anti-static and anti-magnetic features.

f. Though the capacity of the programme may restrict the colour range the VDU now have to colour capability of potential display of million colours, (with 24-bit memory).

g. These screens can be commonly transferred between different computing environments. Now the screens support the array of graphic adaptors.

h. Let us see how the display takes place on the colour monitor from the CPU (Central Processing Unit).

ii. Printers and Plotters :

a. For viewing the image in a hard copy form displays are necessary such as on paper.

b. For process of printing a large number of printers and plotters are available in the market.

c. Before these printer or plotters are purchased the user must think about speed the throughput of output nature of output size type, quantity and quality of output the requirement of paper and ink etc.

d. Dot matrix printer, Laser printer and Ink-jet printer are the types of printers and plotters which are commonly used in GIS.

Que 3.13. Write a short note on :

A. Dot matrix printer/line printer.
B. Laser printer.
C. Ink-jet printer.
D. Line or vector plotter.
E. Thermal plotter.

Answer

A. Dot Matrix Printer/Line Printer :

1. They are the low cost and very popular output devices. These are used for both *i.e.*, high volume output of textual documents or for slow output of graphical material like maps, graphs, charts etc.
2. The general size of output is A4 size but many devices can produce A3 size or longer output on a traction paper.
3. The speed varies between 300 and 2000 lines/min. The speed depends upon the setting of the printer and on the quality of the device.
4. The output is via series of dots with the resolution depending up on the density of pins on the print head. (It is in the range between 70 and 150 dots/per inch). Multiple colour ribbons can be used to get a limited range of colours.
5. From the dot matrix printers, the output is crude, noisy. If they are to be indged on the basis of cost, some people still go for these devises.

B. Laser Printer :

1. Use of laser technology has made these printers have very high quality and almost silent output of textual and graphical information.
2. Till the recent past the output used to be in black and white only but now this technology has succeeded in giving colourful outputs and has reduced their prices also.
3. These printers have high variations in size *i.e.*, it is available from the small A4 size model, which is easily portable and having an output of 15 pages per minute with the resolution of 300 dots per Inch, up to a large A0 size model with the resolution varying between 400 and 600 dots per inch.
4. These large size printers have the output almost equal to the output of conventional offset printing.

C. Ink-jet Printer :

1. These printers are cheper than the laser printers and they are based on a different type of technology.
2. The output is obtained by pushing an ink through the small nozzle which from the microscopic droplets.
3. These droplets strike the printing media as per the commods given. Infinite array of colours can be achieved by mixing any combination of the Red, Green, and blue the basic three colours by using the multiple nozzles.
4. The resolution varies between 120 and 300 dots/per inch.
5. The speed is comparatively slow but with the latest improvements in their price, speed resolution and reliability.
6. These printers have become very popular as the output device of GIS.
7. In near future this technology will provide an all-round solution to the needs of the users of GIS.

D. Line or Vector Plotter :

1. These are of two types of pen plotters such as drum or roller type and flat-bed type plotters.
2. Each of these two same advantages :

i. Both use cartage pens (which can be of variable colours or line width) both, produce vector or line output.

ii. This output corresponds to the grid co-ordinates which is in the computer file ; to that, they are linked.

iii. The speed is upto 100 lines per cm/per sec.

3. The only limitation of this technology is that it needs constant supervision to avoid the situation of clogging of pens or pens running out of ink etc.

4. Drum plotters consist of a drum which rotates in both the directions.
5. A roll of paper or any other drawing media is attached to the drum.
6. The pen or pens move, horizontally in both the directions along a cartage to plot lines.
7. The width of the drum plotters varies between 20 cm and 150 cms. The output can be upto eight colours.

E. Thermal Plotter :

1. They use the local heating to warm, the thermo-sensitive paper. The paper is coated with two separate colourless components. After heating, this combination produces a wide-range of colours, having a reasonable quality.
2. They produce the output in raster format upto 15 metres length. They have the resolution of over 400 dots/ inch though these plotters are costly, they have several advantages like, they have no cartridges, or toner or ink are required.
3. As the ink gets absorbed automatically no feathering of line is necessary. They run almost unattended.

Que 3.14. Write a short note on data exploration in GIS.

Answer

Data Exploration in GIS :

1. Data exploration is the initial step in data analysis, where users explore a large data set in an unstructured way to uncover initial patterns, characteristics, and points of interest.
2. This process is not meant to reveal every bit of information a dataset holds, but rather to help create a broad picture of important trends and major points to study in greater detail.
3 Data exploration can use a combination of manual methods and automated tools such as data visualizations, charts, and initial reports.
4. This process makes deeper analysis easier because it can help target future searches and begin the process of excluding irrelevant data points and search paths that may turn up no results.
5. More importantly, it helps build a familiarity with the existing information that makes finding better answers much simpler.
6. Many times, data exploration uses visualization because it creates a more straight forward view of datasets than simply examining thousands of individual numbers or names.
7. In any data exploration, the manual and automated aspects also look at different sides of the same coin. Manual analysis helps users familiarize themselves with information and can point to broad trends.

Que 3.15. Explain the geospatial analysis.

Answer

Geospatial Analysis :

1. Geospatial analysis is the gathering, display, and manipulation of imagery, GPS, satellite photography and historical data, described explicitly in terms of geographic co-ordinates or implicitly, in terms of a street address, postal code, or forest stand identifier as they are applied to geographic models.
2. In the case of vector-based GIS this typically means operations such as map overlay (combining two or more maps or map layers according to predefined rules), simple buffering (identifying regions of a map within a specified distance of one or more features, such as towns, roads or rivers) and similar basic operations.
3. For raster-based GIS, widely used in the environmental sciences and remote sensing, this typically means a range of actions applied to the grid cells of one or more maps (or images) often involving filtering and/or algebraic operations (map algebra).
4. These techniques involve processing one or more raster layers according to simple rules resulting in a new map layer, for example replacing each cell value with some combination of its neighbours' values, or computing the sum or difference of specific attribute values for each grid cell in two matching raster datasets.
5. Descriptive statistics, such as cell counts, means, variances, maxima, minima, cumulative values, frequencies and a number of other measures and distance computations are also often included in this generic term spatial analysis.
6. Spatial analysis includes a large variety of statistical techniques (descriptive, exploratory, and explanatory statistics) that apply to data that vary spatially and which can vary over time.

PART-4

Co-ordinate System : Geographic Co-ordinate System, Approximation of Earth, Datum : Map Projection, Types of Map Projection, Map Projection Parameters, Commonly used Map Projection, Projected Co-ordinate System.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 3.16. **What do you mean by co-ordinate system in GIS ?**

Answer

Geographic Coordinate System (GCS) :

1. A geographic coordinate system, also known as global or spherical coordinate system is a reference system that uses a three-dimensional spherical surface to determine locations on the earth. Any location on earth can be referenced by a point with longitude and latitude.
2. We must familiarize ourselves with the geographic terms with respect to the Earth coordinate system in order to use the GIS technologies effectively. Following are the technological terms are used in GCS:

i. **Pole :** The geographic pole of earth is defined as either of the two points where the axis of rotation of the earth meets its surface. The North Pole lies 90º north of the equator and the South Pole lies 90º south of the equator

ii. **Latitude :** Imaginary lines that run horizontally around the globe and are measured from 90º north to 90º south. Also known as parallels, latitudes are equidistant from each other.

iii. **Equator :** An imaginary line on the earth with zero degree latitude, divides the earth into two halves-Northern and Southern Hemisphere. This parallel has the widest circumference.

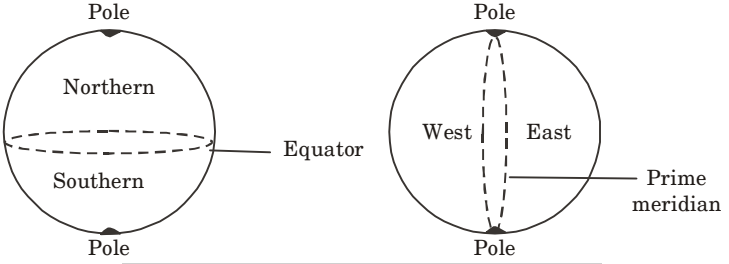


Fig. 3.16.1. Division of Earth into hemispheres.

iv. **Longitude :** Imaginary lines that run vertically around the globe. Also known as meridians, longitudes are measured from 180º east to 180º west. Longitudes meet at the poles and are widest apart at the equator.

v. **Prime Meridian :** Zero degree longitude which divides the Earth into two halves-Eastern and Western hemisphere. As it runs through the Royal Greenwich Observatory in Greenwich, England it is also known as Greenwich meridian

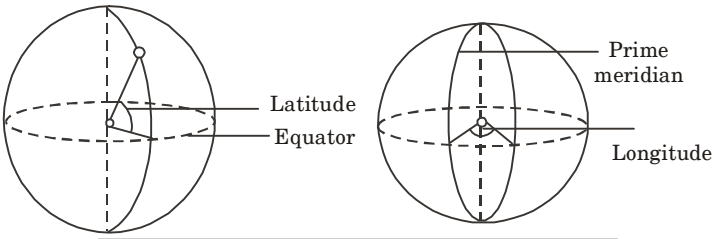


Fig. 3.16.2. Latitude and longitude measurements.

3. Equator (0°) is the reference for the measurement of latitude. Latitude is measured north or south of the equator.
4. For measurement of longitude, prime meridian (0°) is used as a reference. Longitude is measured east or west of prime meridian.
6. The grid of latitude and longitude over the globe is known as graticule. The intersection point of the equator and the prime meridian is the origin (0, 0) of the graticule.

Que 3.17. What do you understand by map projection and what are the classification of map projections ?

Answer

Map Projection:

1. Map projection is a mathematical expression using which the three-dimensional surface of Earth is represented in a two dimensional plane. The process of projection results in distortion of one or more map properties such as shape, size, area or direction.
2. A single projection system can never account for the correct representation of all map properties for all the regions of the world. Therefore, hundreds of projection systems have been defined for accurate representation of a particular map element for a particular region of the world.

Classification of Map Projections :

Map projections are classified on the following criteria :

1. Method of Construction : The term map projection implies projecting the graticule of the Earth onto a flat surface with the help of shadow cast. However, not all of the map projections are developed in this manner. Some projections are developed using mathematical calculations only. Following are the projections that are based on the method of construction:

i. Perspective Projections : These projections are made with the help of shadow cast from an illuminated globe on to a developable surface.

ii. Non-Perspective Projections :

a. These projections do not use shadow cast from an illuminated globe on to a developable surface.

b. A developable surface is only assumed to be covering the globe and the construction of projections is done using mathematical calculations.

2. Development Surface : Projection transforms the co-ordinates of Earth on to a surface that can be flattened to a plane without distortion (shearing or stretching). Such a surface is called a developable surface. The three basic projections are based on the types of developable surface and are introduced below:

i. Cylindrical Projection.

ii. Conic Projection.

iii. Planer, Azimuthal or Zenithal Projection.

3. Projection Properties :

According to properties map projections can be classified as :

i. Equal Area Projection : It is also known as homolographic projections. The areas of different parts of earth are correctly represented by such projections.

ii. True Shape Projection : It is also known as orthomorphic projections. The shapes of different parts of earth are correctly represented on these projections.

iii. True Scale or Equidistant Projections : Projections that maintain correct scale are called true scale projections. However, no projection can maintain the correct scale throughout. Correct scale can only be maintained along some parallel or meridian.

4. Position of Light Source : Placing light source illuminating the globe at different positions results in the development of different projections. These projections are :

i. Gnomonic projection : When the source of light is placed at the centre of the globe.

ii. Stereographic Projection : When the source of light is placed at the periphery of the globe, diametrically opposite to the point at which developable surface touches the globe.

iii. Orthographic Projection : When the source of light is placed at infinity from the globe opposite to the point at which developable surface touches the globe.

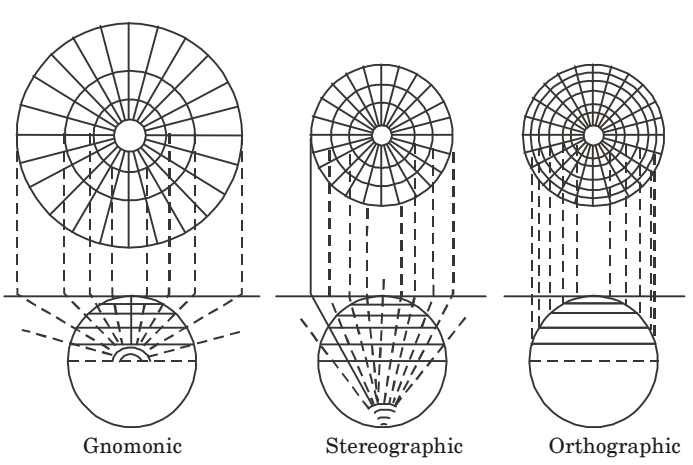


Fig. 3.17.1. Projections and position of light source.

Que 3.18. What do you mean by development surface in map projection and what are the basic projections based on the develpable surface ?

Answer

Development Surface : Refer Q.3.17, Page 3–19H, Unit-3.

Types : The three basic projections are based on the types of developable surface and are introduced below :

1. Cylindrical Projection :

i. It can be visualized as a cylinder wrapped around the globe.

ii. Once the graticule is projected onto the cylinder, the cylinder is opened to get a grid like pattern of latitudes and longitudes.

iii. The longitudes (meridians) and latitudes (parallels) appear as straight lines.

iv. Length of equator on the cylinder is equal to the length of the equator therefore is suitable for showing equatorial regions.

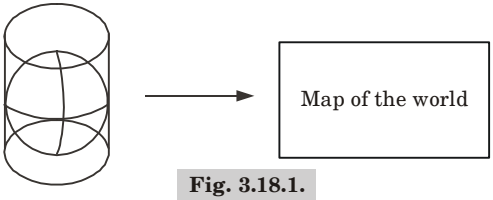
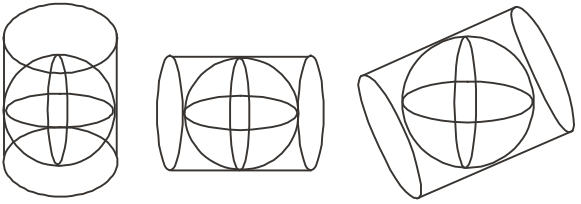


Fig. 3.18.1.

Aspects of cylindrical projection :



(*a*) (*b*) (*c*)

Fig. 3.18.2.

a. Normal : When cylinder has line of tangency to the equator. It includes Equirectangular Projection, the Mercator projection, Lambert's Cylindrical Equal Area, Gall's Stereographic Cylindrical, and Miller cylindrical projection.

b. Transverse : When cylinder has line of tangency to the meridian. It includes the Cassini Projection, Transverse Mercator, Transverse cylindrical Equal Area Projection, and Modified Transverse Mercator.

c. Oblique : When cylinder has line of tangency to another point on the globe. It only consists of the oblique mercator projection.

2. Conic Projection :

i. It can be visualized as a cone placed on the globe, tangent to it at some parallel.

ii. After projecting the graticule on to the cone, the cone is cut along one of the meridian and unfolded. Parallels appear as arcs with a pole and meridians as straight lines that converge to the same point.

iii. It can represent only one hemisphere, at a time, northern or southern.

iv. Suitable for representing middle latitudes.

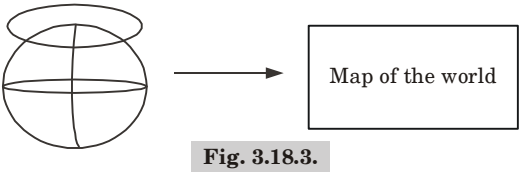
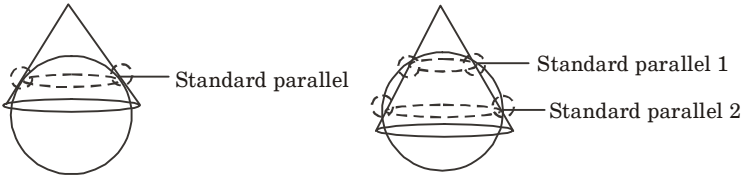


Fig. 3.18.3.

Aspects of Conic Projection :



(*a*) (*b*)

Fig. 3.18.4.

a. Tangent : When the cone is tangent to only one of the parallel.

b. Secant : When the cone is not big enough to cover the curvature of Earth, it intersects the Earth twice at two parallels.

3. Planer, Azimuthal or Zenithal Projection :

i. It can be visualized as a flat sheet of paper tangent to any point on the globe.

ii. The sheet will have the tangent point as the centre of the circular map, where meridians passing through the centre are straight line and the parallels are seen as concentric circle.

iii. Suitable for showing polar areas.

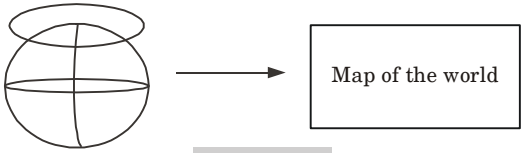


Fig. 3.18.5.

Aspects of zenithal projection :

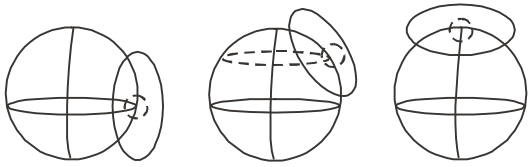


Fig. 3.18.6.

a. Equatorial Zenithal : When the plane is tangent to a point on the equator.

b. Oblique Zenithal : When the plane is tangent to a point between a pole and the equator.

c. Polar Zenithal : When the plane is tangent to one of the poles.

Que 3.19. What are the selection of map projection of an area ?

Answer

Selection of Map Projection :

Choosing a correct map projection for an area depends on the following:

1. Map Purpose : Considering the purpose of the map is important while choosing the map projection. If a map has a specific purpose, one may need to preserve a certain property such as shape, area or direction.

On the basis of the property preserved, maps can be categorized as following :

i. Maps that Preserve Shapes : Used for showing local directions and representing the shapes of the features. Such maps include :

a. Topographic and cadastral maps.

b. Navigation charts (for plotting course bearings and wind direction).

c. Civil engineering maps and military maps.

d. Weather maps (for showing the local direction in which weather systems are moving).

ii. Maps that Preserve Area : The size of any area on the map is in true proportion to its size on the earth. Such projections can be used to show :

a. Density of an attribute e.g. population density with dots.

b. Spatial extent of a categorical attribute e.g. land use maps.

c. Quantitative attributes by area e.g. Gross Domestic Product by country.

d. World political maps to correct popular misconceptions about the relative sizes of countries.

iii. Maps that Preserve Scale : Preserves true scale from a single point to all other points on the map. The maps that use this property include :

a. Maps of airline distances from a single city to several other cities.

b. Seismic maps showing distances from the epicenter of an earthquake.

c. Maps used to calculate ranges; for example, the cruising ranges of airplanes or the habitats of animal species.

iv. Maps that Preserve Direction : On any Azimuthal projection, all azimuths, or directions, are true from a single specified point to all other points on the map. On a conformal projection, directions are locally true, but are distorted with distance.

2. Study Area :

i. Geographical Location :

a. The line of zero distortion for a cylindrical projection is equator. For conical projections it is parallels and for Azimuthal it is one of the poles.

b. If the study area is in tropics use cylindrical projection, for middle latitudes use conical and for Polar Regions use Azimuthal projections.

ii. Shape of the Area :

a. Young in 1920 described a way of selecting the map projection which is known as Young's rule.

b. According to this rule, if the ratio of maximum extent (z) (measured from the centre of the country to its most distant boundary) and the width of the country comes out to be less than 1.41, azimuthal projection is preferable.

c. If the ratio is greater than 1.41, a conical or cylindrical projection should be used.

Que 3.20. Describe the map projection parameter.

Answer

Map Projection Parameters : Following are the projection parameter :

1. Linear Parameters :

i. False easting is a linear value applied to the origin of the *x*-co-ordinates. false northing is a linear value applied to the origin of the *y*-co-ordinates.

ii. False easting and northing values are usually applied to ensure that all *x*-and *y*-values are positive. We can also use the false easting and northing parameters to reduce the range of the *x*- or *y*-co-ordinate values. For example, if you know all *y*-values are greater than 5,000,000 meters, you could apply a false northing of -5,000,000.

iii. Height defines the point of perspective above the surface of the sphere or spheroid for the vertical near-side perspective projection.

2. Angular Parameters :

i. Azimuth defines the center line of a projection. The rotation angle measures east from north. This is used with the azimuth cases of the Hotine Oblique Mercator, rectified skew orthomorphic, and Local projections.

ii. Central meridian defines the origin of the *x*-co-ordinates.

iii. Longitude of origin defines the origin of the *x*-co-ordinates. The central meridian and longitude of origin parameters are synonymous.

iv. Central parallel defines the origin of the *y*-co-ordinates.

v. Latitude of origin defines the origin of the *y*-co-ordinates. This parameter may not be located at the center of the projection.

vi. In particular, conic projections use this parameter to set the origin of the *y*-co-ordinates below the area of interest.

vii. In that instance, you do not need to set a false northing parameter to ensure that all y-coordinates are positive.

3. Unitless Parameters :

i. Scale factor is a unitless value applied to the center point or line of a map projection.

ii. The scale factor is usually slightly less than one. The Universal Transverse Mercator (UTM) coordinate system, which uses the Transverse Mercator projection.

iii. This creates two almost parallel lines approximately 180 kilometers, or about 1°, away where the scale is 1.0. The scale factor reduces the overall distortion of the projection in the area of interest.

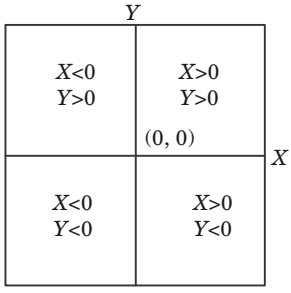
Que 3.21. Describe the projected co-ordinate system.

Answer

Projected Co-ordinate System :

1. A projected co-ordinate system is defined on a flat, two-dimensional surface. Unlike a geographic co-ordinate system, a projected co-ordinate system has constant lengths, angles, and areas across the two dimensions.
2. A projected co-ordinate system is always based on a geographic co-ordinate system that is based on a sphere or spheroid.
3. In a projected coordinate system, locations are identified by x, y co-ordinates on a grid, with the origin at the center of the grid. Each position has two values that reference it to that central location.
4. One specifies its horizontal position and the other its vertical position. The two values are called the x-co-ordinate and y-co-ordinate. Using this notation, the co-ordinates at the origin are $x = 0$ and $y = 0$.
5. On a gridded network of equally spaced horizontal and vertical lines, the horizontal line in the center is called the x-axis and the central vertical line is called the y-axis.
6. Units are consistent and equally spaced across the full range of x and y. Horizontal lines above the origin and vertical lines to the right of the origin have positive values; those below or to the left have negative values.
7. The four quadrants represent the four possible combinations of positive and negative X and Y coordinates.

8. When working with data in a geographic coordinate system, it is sometimes useful to equate the longitude values with the *X* axis and the latitude values with the *Y* axis.



VERY IMPORTANT QUESTIONS

Following questions are very important. These questions may be asked in your SESSIONALS as well as UNIVERSITY EXAMINATION.

Q. 1. Define the Geographical Information System (GIS).

Ans. Refer Q. 3.1, Unit-3.

Q. 2. List important functions of GIS and explain any one in detail.

Ans. Refer Q. 3.3, Unit-3.

Q. 3. What do you understand by spatial data ? How is the spatial relationship represented ?

Ans. Refer Q. 3.4, Unit-3.

Q. 4. Write a short note on non-spatial data.

Ans. Refer Q. 3.6, Unit-3.

Q. 5. Describe the data capture and input of GIS.

Ans. Refer Q. 3.8, Unit-3.

Q. 6. Explain the data storage of GIS.

Ans. Refer Q. 3.11, Unit-3.

Q. 7. How the data display is carried out ?

Ans. Refer Q. 3.12, Unit-3.

Q. 8. Explain the geospatial analysis.

Ans. Refer Q. 3.15, Unit-3.

Q. 9. What do you understand by map projection and what are the classification of map projections ?

Ans. Refer Q. 3.17, Unit-3.

Q. 10. What are the selection of map projection of an area ?

Ans. Refer Q. 3.19, Unit-3.

Q. 11. Describe the projected co-ordinate system.

Ans. Refer Q. 3.21, Unit-3.

4
UNIT

Vector Data Model

CONTENTS

PART-1

Vector Data Model Representation of Simple Features-Topology and its Importance : Coverage and its Data Structure, Shape Files, Data Models for Composite Features Objects Based Vector.

Questions-Answers

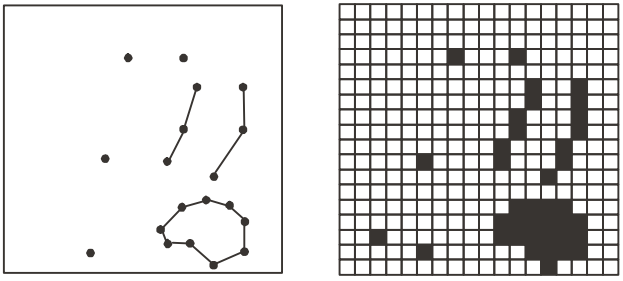
Long Answer Type and Medium Answer Type Questions

Que 4.1. What do you mean by the data structure for GIS ?

Answer

Data Structure for GIS :

1. Data for a GIS must be represented in a form that preserves locational identities of each unit of information, so that it is possible to retrieve data by location and therefore to depict and analyse geographic patterns.
2. Because data are frequently derived from a 'conventional' (non-digital) map or image, it is necessary to convert them into digital form suitable for use by a GIS.
3. This process, known as geocoding, records the pattern/features of a map in a form that can be accepted and manipulated by computers.
4. The simple spatial objects may be coded in two different formats (vector and raster) for storing and manipulating these spatial data in a GIS.
5. Both of these data structures, also called data models or sometimes data formats, offer contrasting advantages and disadvantages.
6. When data are depicted in the vector format, a combination of points, lines and strings, an area is used, whereas the raster format uses pixels and grid cells.
7. Fig. 4.1.1 shows a representation of simple spatial objects in vector and raster models.
8. Usually, a GIS must be designed on either a raster or a vector format.
9. Because of differences in equipment, computer programs, and expertise required for the two different approaches, the choice depends upon the facilities available, the kinds of data to be examined, and the purposes of establishing the GIS.
10. Also, it is possible to convert from vector-to-raster format by applying relatively straight forward computer algorithms, but it is a little difficult to do raster to vector conversion.



(*a*) Vector model (*b*) Raster model

Fig. 4.1.1. Spatial data models.

Que 4.2. Explain vector data model.

Answer

Vector Data Model :

1. The vector model is close to the traditional mapping approach where the objects are represented as points, lines, or areas.
2. In a vector model, the positions of points, lines, and areas are precisely specified.
3. The position of each object is defined by a series of co-ordinate pairs.
4. Vectors are graphical objects that have geometrical primitives such as points, lines, and polygons to represent geographical entities in computer graphics.
5. Vectors have a precise direction, length, and shape, and can be defined by co-ordinate geometry.
6. A point is described by a single $x - y$ co-ordinate pair and by its name or label. A line is described by a set of co-ordinate pairs and by its name or label.
7. In reality, a line is described by an infinite number of points. In practice, this is not a feasible way of storing a line. Therefore, a line is built up by its starting and ending coordinate pairs.
8. An area, also called a polygon, is described by a set of coordinate pairs and by its name or label.
9. Vector data model are classified on the basis of :

i. Object-based vector model.

ii. Field-based vector model.

Que 4.3. **What are the three basic spatial entities and how are these used to portray geographical features on paper maps and in GIS ?**

OR

What do you understand by spatial data ? How is the spatial relationship represented ?

Answer

A. Spatial Data :

1. It is also called graphical data, it consists of natural and cultural features that can be shown with lines or symbols on maps, or that can be seen as images on photographs.
2. The data in the different forms (maps, photographs, images, etc,) being in non-compatible formats create problems while integrating in GIS.
3. In a GIS, these data must be represented and spatially located in digital form, by using a combination of fundamental elements called simple spatial objects (SSO).
4. These SSO include points, lines and strings, areas or polygons, pixels, and grid cells.
5. SSO can be represented by their respective symbols.
6. The spatial data represented as either layers or objects are simplified by breaking down all geographic features with three basic entity types, points, lines and areas, before they can be stored in the computer.

B. Spatial Entities : The basic spatial entities are as follows :

1. **Point :** Its requirement is for geographical reference to locate it with respect to other spatial entities. Point data consist of observations that occur only at points or occupy very small areas in relation to the scale of the database. These define single geometric positions as shown in Fig. 4.3.1(*a*).
2. **Line and String :** It is ordered set of points (known as an arc, segment or chain) with defined start and end points (nodes) which also give the line direction. A line connects two points, and a string is a sequence of two or more lines as shown in Fig. 4.3.1(*b*).
3. **Areal :** It provides data about the points and lines used in construction of the area, and how these are connected to define the boundary. An area or polygon consists of a continuous space within three or more connected lines as shown in Fig. 4.3.1(*c*).
4. **Pixels :** These are usually tiny squares that represent the smallest elements into which a digital image is divided as shown in Fig. 4.3.1(*d*).

Continuous array of pixels, arranged in rows and columns, are used to enter data from aerial photos, satellite images etc.

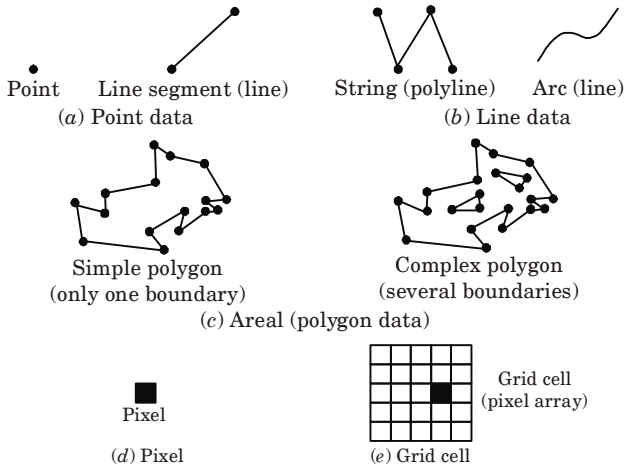


Fig. 4.3.1. Representation of entities.

5. Grid Cells : These are single elements, usually square, within a continuous geographic variable. Grid cells may be used to represent terrain slopes, soil types, land cover etc., as shown in Fig. 4.3.1 (*e*).

C. Relationship :

1. Spatial relationships are connections between spatial objects when geometric properties are considered.
2. Three types of spatial relationships have been recognized, *i.e.*, topological, metric and ordinal.
3. Here, topological relationships are those that do not change under topological transformation, e.g., the connectivity of two objects, metric relationships are those described by measures of a metric space, and distances and angles are of those relations, ordinal relationships are represented by relative orders between objects, which are often described by prepositions such as before and behind.
4. These three types of spatial relationships are perhaps major ones, but unfortunately, they are not comprehensive.

Que 4.4. **What is topology and why it is important in GIS ?**

Answer

Topology in GIS :

1. Topology in GIS is generally defined as the spatial relationships between adjacent or neighboring vector features (points, polylines and polygons).
2. In GIS, topology is implemented through data structure.

Importance of Topology in GIS :

In terms of functionality, topology is important to GIS in (at least) three important ways :

1. Topology is necessary for certain spatial functions such as network routing through linear networks. Here the idea is that if line features do not share common nodes, that routes cannot be established through the network.
2. Topology can be used to create data sets with better quality control and greater data integrity. Topology rules can be created so that edits made to a dataset can be 'validated' and show errors in that dataset. An example would be the creation of a new manhole/sewer access feature outside a polygon dataset of road features.
3. By creating topological relationships between feature classes, features can be shared across feature classes. In other words, if you open one dataset and edit/move a line feature that is shared between two feature classes, then both feature classes will be updated to reflect the edits.
4. This is massively helpful for keeping datasets synchronized. An example would be a river feature that defines an administrative boundary (where the river moves over time), or the boundary of a municipal area and zoning polygons.

Que 4.5. Write a short note on the coverage of vector data.

Answer

Coverage of Vector Data :

1. A coverage is a georelational data model that stores vector data. It contains both the spatial (location) and attribute (descriptive) data for geographic features.
2. Coverages use a set of feature classes to represent geographic features. Each feature class stores a set of points, lines (arcs), polygons, or annotation (text).
3. Coverages can have topology, which determines the relationships between features.

4. The coverage supports three basic topological relationships :

i. **Connectivity :** Arcs connect to each other at nodes.

ii. **Area Definition :** An area is defined by a series of connected arcs.

iii. **Contiguity :** Arcs have directions and left and right polygons.

Que 4.6. What do you mean by shapefile in GIS ?

Answer

Shape File in GIS :

1. A shapefile is a simple, non-topological data structure for storing the geometric location and attribute in formation of geographic features.
2. Geographic features in a shape file can be represented by points, line, or polygons (area).
3. However, unlike other simple graphic data structures, shapefile polygons are represented by one or more rings.
4. A ring is a closed, non-self-intersecting loop. This structure can represent complex structures, such as polygons, that contain "islands."
5. The vertices of a ring maintain a consistent, clockwise order so that the area to the right, as one "walks" along the ring boundary, is inside the polygon, and the area to the left is outside the polygon.
6. Moreover, polygon features in shape file format can contain one or more parts, so that distinct and overlapping features can be represented.
7. For example, an individual parcel that is split by a road can be represented alternatively as two separate polygons with two rings and two records in the attribute table or as one polygon with two parts and one record in the attribute table.
8. A primary advantage of shapefiles is that this simple file structure draws faster than a coverage does.

Que 4.7. Describe in brief of data models for composite features.

Answer

Data Models for Composite Features :

1. Composite features refer to those spatial features that are better represented as composites of points, lines, and polygons.
2. Composite features include TINs (Triangulated Irregular Networks), regions, and routes.

3. **TIN :** A TIN approximates the terrain with a set of non-overlapping triangles.

4. **Regions :**

i. A region is a geographic area with similar characteristics.

ii. A data model for regions must be able to handle two spatial characteristics.

iii. A region may have spatially joint or disjoint areas, and regions can overlap or cover the same area.

5. **Routes :** A route is a linear feature such as a highway, a bike path, or a stream but, unlike other linear features, a route has a measurement system that allows linear measures to be used on a projected co-ordinate system.

Que 4.8. **Describe the objects based data of vector model.**

Answer

Objects Based Data of Vector Model :

1. The object based data model treats spatial data as objects. It differs from the georelational data model in two important aspects.
2. The object based data model stores both the spatial and attribute data of spatial features in a single system.
3. The object based data model allows a spatial feature (object) to be associated with a set of properties and methods.
4. An object based spatial database is a spatial database that stores the location as objects. The object based spatial model treats the world as surface littered with recognizable objects (e.g., cities, rivers), which exist independent of their locations.
5. Objects can be simple as polygons and lines, or be more complex to represent cities.
6. While a field-based data model sees the world as a continuous surface over which features (e.g., elevation) vary, using an object based spatial database, it is easier to store additional attributes with the objects, such as direction, speed, etc.
7. Storing attributes with objects can provide better result presentation and improved manipulation capabilities in a more efficient way.
8. In a field-based data model, this information is usually stored at different layers and it is harder to extract different information from various layers.

Que 4.9. What are the advantages and disadvantages of vector data over raster data ?

Answer

1. Advantages of Vector Data Over Raster Data :

i. A vector database can depict point data as points which can be positioned accurately. However, a raster database can depict point data only at the level of the detail of a single cell. This leads to loss of accuracy.

ii. A vector database can show a line data in exact and fine detail, whereas a raster database can show the same line as a zig-zag or a comparatively more smooth line depending upon the resolution of the cell.

iii. A vector database provides details and exact and fine boundaries among aerial patterns, e.g., land cover. However, in case of a raster database, the accuracy is lost for the reason explained earlier.

iv. Discrete quantitative data such as population, which are grouped/ associated with an area, are best depicted in finer detail by polygons (vector format). However, continuous data such as topographic elevation and contours, represented by a network of equally spaced observations, can probably be most directly presented by a raster format.

v. A vector database is best suited to represent various natural/artificial features and also these can be presented mathematically (co-ordinates). This makes the vector format conceptually more complex than the raster format.

vi. A vector database requires less storage space on the computer as compared to a raster database for the same information. Also, the vector formats are more accurate and present a finer detail of shapes and sizes as compared to the raster format.

2. Disadvantages of Vector Data over Raster Data :

i. Vector formats sometimes prove costlier because of higher data-encoding cost. Also, the programs for data manipulation are more complex as compared to the raster format.

ii. In case of the vector format, the superimposition or overlaying of different layers of data may be difficult because some polygons in different layers may not match exactly due to minor digitization errors, forming small slivers or strips.

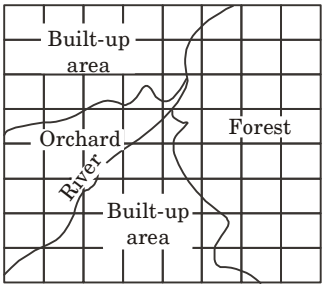
Que 4.10. Explain how data can be converted from vector to raster format.

Answer

Vector to Raster Conversion :

1. Vector to raster conversion is also referred to as coding.
2. Fig. 4.10.1(*a*) shows a vector data/format (map) of the vector representation of the land-cover map overlaid or superimposed on a raster of grid cells.
3. The size of these cells will depend upon the accuracy desired, time and computing facility available.
4. Fig. 4.10.1(*b*) illustrates the raster representation of vector counter parts of raster data using a coarse-resolution grid cell of the region of the land-cover map and that using a finer-resolution grid cell is shown in Fig. 4.10.1(*c*).
5. The finer-resolution grid renders depiction/storage of areas with greater precision. Of course, the fine-resolution grid cell size will yield better results but will demand more time and computing facility and results in higher costs.
6. The vector counter parts of the raster data can be input by the four methods. Of these, the presence/absence and dominant types are the best method and are used depending upon the importance felt by the user.
7. In the presence/absence method, for each grid cell, a decision is made as to whether the selected entity exists at the centre of the given grid cell or not.
8. In the presence/absence method, the cell is assigned a value corresponding to the characteristics (vector location) of its centre.
9. Thus, for example, the centre of the cell (3, 4) is occupied by an orchard and hence this cell is assigned the value O or 2, as shown in Fig. 4.10.2(*b*). If it does not, it is ignored.
10. The cell in the precedence method is allotted a value corresponding to the most important characteristics or precedence with respect to the other characteristics present in it.
11. For example, in the cell (6, 3), there are three different characteristics, viz., orchard, river and built-up area.
12. Though the river in this cell occupies the least area; it is the most important among the three features, and also the liver cannot be discontinuous.
13. Thus, among the three characteristics of this cell, the river is given precedence over others and accordingly this cell is coded as *R* or 3, as shown in Fig. 4.10.2(*c*).

14. In the dominant type of conversion or coding, each cell of a grid is assigned a value corresponding to predominant characteristics of the area within the cell.
15. For example, two different types of areas, viz., built-up area and orchard occupy.
16. The cell is assigned the value *B* or 1, as shown in Fig. 4.10.2(*d*), because the larger part (more than 50 percent) of the cell is occupied by buildings.



Built-up area : I, B
Orchard : O, 2
River : R, 3
Forest : F, 4

(*a*) Vector representation of map over grid cell

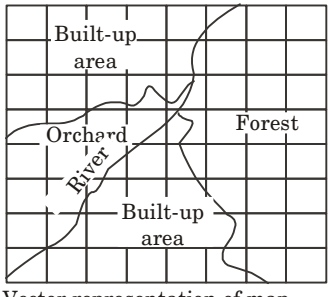
B	B	B	B	R	R	F	F
B	B	B	B	R	F	F	F
B	B	B	O	R	F	F	F
B	O	O	R	R	F	F	F
O	O	R	B	B	F	F	F
O	R	R	B	B	F	F	F
O	R	B	B	B	B	F	F
R	B	B	B	B	B	F	F

(*b*) Coarse-resolution grid cell

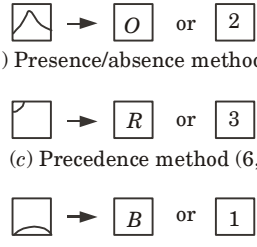
B	B	B	B	B	B	B	B	B	B	B	R	F	F	F	F
B	B	B	B	B	B	B	B	B	B	R	F	F	F	F	F
B	B	B	B	B	B	B	B	B	B	R	F	F	F	F	F
B	B	B	B	B	B	B	B	B	R	F	F	F	F	F	F
B	B	B	B	B	B	B	B	B	R	F	F	F	F	F	F
B	B	B	B	O	O	O	O	O	R	F	F	F	F	F	F
B	B	B	B	O	O	O	O	R	F	F	F	F	F	F	F
O	O	O	O	O	O	O	R	B	B	F	F	F	F	F	F
O	O	O	O	O	R	B	B	B	F	F	F	F	F	F	F
O	O	O	O	R	B	B	B	B	F	F	F	F	F	F	F
O	O	O	O	R	B	B	B	B	F	F	F	F	F	F	F
O	O	O	R	B	B	B	B	B	B	F	F	F	F	F	F
O	O	R	B	B	B	B	B	B	B	F	F	F	F	F	F
R	R	B	B	B	B	B	B	B	B	B	F	F	F	F	F
B	B	B	B	B	B	B	B	B	B	B	B	B	F	F	F

(*c*) Fine-resolution grid cell

Fig. 4.10.1. Raster representation of land-cover map.



(*a*) Vector representation of map overlaid on a coarse grid



(*b*) Presence/absence method (3, 4)

(*c*) Precedence method (6, 3)

(*d*) Dominant method (3, 3)

Fig. 4.10.2. Data conversion from vector to raster format.

Que 4.11. What are the analytical capabilities of GIS ?

Answer

Analytical Capabilities of GIS :

1. Organisation : Map overlay analysis is the most important function it is discussed in sections to follow :

i. The importance of data organisation can be revealed by a person who has collected a large mass of data for any particular purpose.

ii. Data can be arranged in many ways, and unless the organisation scheme is suitable for the application at hand, useful information can not be easily extracted.

2. Visualisation :

i. Visualisation is achieved in GIS with colour and by specialised methods using perspective, shadowing and other means.

ii. The graphical capabilities of computers are exploited by transforming a table of data, for example, into a visual display through which the spatial associations can be visualized.

iii. Complex relationship probably can be better understood by visual display rather than from a table of data. Further a visual display can be manipulated to give alternative views/representation of the data, thereby enhancing the capability to analyse the anomalies and patterns through GIS.

3. Combination :

i. The ability to merge spatial data sets from quite different sources their manipulation and subsequent display can often lead to an understanding and interpretation of spatial phenomena that are simply not apparent when individual spatial data types are considered in isolation.

ii. The data measuring activity combines image data for a certain geographic area with other reference data of the same area.

iii. The GIS operator may overlay multiple images of this area at different dates is a technique used for identifying changes over time, for example, monitoring of forest fire or spreading of disease in tree species.

iv. The process of combining layers of spatial data is sometimes called data integration and can be carried out either by visualising composite displays of various kinds, or with integration models that effectively create a new map from two or more existing maps.

4. Prediction :

i. Prediction is one of the purposes of GIS. For example, a number of data layers indicating population data in different regions of a city along with the growth patterns and civic facilities might be combined together to predict the future population at the desired time in different parts of the city.

ii. Such a map may then be used as a basis for making city development decisions.

iii. Prediction may sometimes also be a research exercise to explore the outcome of making a particular set of assumptions, often with the purpose of examining the performance of a model.

5. Queries :

i. Since GIS is a decision support system, performing queries on a GIS database to retrieve information (data) is its essential part.

ii. Queries offer a method of data retrieval, and can be performed on data that are part of the GIS database, or on new data produced as a result of data analysis.

iii. These are useful at all stages of GIS analysis for checking the quality of data and the results obtained.

iv. A GIS typically stores spatial and non-spatial (also called aspatial or attribute) data in two separate files.

v. The GIS has capability to search and display spatial data based on attribute criteria and vice-versa.

vi. Accordingly, there are two general types of query that can be performed with GIS : spatial and non-spatial.

6. Reclassification :

i. Although query is the most widely used function to retrieve data from a GIS database, irrespective of the vector or raster model, reclassification can also be used in place of query in the raster model.

ii. Consider a land-use image from which we require to extract information on areas of schools.

iii. The answer to this query could be obtained by creating a new coverage that eliminates all unnecessary data.

iv. Reclassification would result in a new image. For example, in a raster image, if cells representing schools in the original image had a value of 30, a set of rules for the reclassification could be :

a. Cells with values 30 (schools) should take the new value of 1.

b. Cells with values other than 30 should take the new value of 0.

PART-2

Data Model : Classes and their Relationships, the Geobased Data Model, Geometric Representation of Spatial Feature and Structure, Topology Rules.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 4.12. What is a data model ? Explain the data models used in GIS.

Answer

A. Data Model :

1. The ways of representing data are known as data models. The data model represents the linkages between the real-world domain of geographical data and the computer (or GIS representation of the features).

2. The process of linkages involves :

i. Identifying the spatial features from the real-world that are of interest in the context to an application and choosing how to represent them in a conceptual model.

ii. Representing the conceptual model by an appropriate data model by choosing between raster or vector approach.

iii. Selecting an appropriate spatial data structure to store the model within the computer.

B. Types of Data Model : Following are two types of data model :

1. Object-based Data Model :

i. In Object-based data model, the geographic space is treated to be filled by discrete and identifiable objects.

ii. An object which is a spatial feature, has identifiable boundaries, relevance to some intended application, and can be described by one or more characteristic knows as attributes.

iii. The spatial objects may be classified as :

a. Exact objects.

b. Inexact objects of fuzzy entities.

2. Field-based Data Model :

i. The field-based data model treats geographic space as populated by one or more spatial phenomena of real-world features varying continuously over space with no obvious or specific extent.

ii. Data for spatial phenomena structured as fields, can be acquired either directly or indirectly by aerial photography, remote sensing, map scanning, and field measurements made at selected or sampled locations, such as topographic data for Triangulated Irregular Networks (TIN).

Que 4.13. What is the difference between the object-based and field-based data models ?

Answer

Difference : Following are the difference between object and field data models :

S. No.	Object-based Data Model	Field-based Data Model
1.	It deals with object oriented blue print of the system.	It deals with entitles at the data base level.
2.	It defines how the application interacts with the information received from an external source.	It defines the table and fields that will store each individual piece of data.
3.	A vector data structure is a computer implementation of an object based ontology.	A raster data structure is a field based implementation.

Que 4.14. Write a short note on geometric representation of spatial feature of data model.

Answer

Geometric Representation of Spatial Feature :

1. Uses geometries of point, polyline, and polygon to represent vector-based spatial features :

i. **Point :** Simple feature with a point or multipoint feature with a set of points.

ii. **Polyline :** Set of line segments which may or may not be connected.

iii. **Polygon :** Made of one or many rings.

iv. **Ring :** Set of connected, closed, non-intersecting line segments.

2. The geodatabase is similar to the shapefile in terms of feature geometries.

3. The geodatabase is also similar to the coverage model in terms of simple features.

4. The difference between two models lies mainly in the composite features of regions and routes.

5. The region sub-class in the coverage model is no longer supported in the geodatabase. Multipart polygon handles the issue related to region.

6. The route sub-class in the coverage model is replace by polylines with m(measure) values in geodatabase model.

Que 4.15. What are the advantages of geodatabase ?

Answer

Advantages of the Geodatabase : Following are the advantages of geodatabase :

1. The hierarchical structure of a geodatabase is useful for data organization and management.

2. The geodatabase, which is part of arc objects, can take advantage of object-oriented technology.

3. The geodatabase offers on-the-fly topology, applicable to features within a feature class or between two or more participating feature classes.

4. Thousands of objects, properties, and methods in arc objects are available for GIS users to develop customized applications.

5. Arc objects provide a template for custom objects to be developed for different industries and applications.

Que 4.16. What are the topology rules in data model ?

Answer

Following are the rules of topology in data model :

1. Polygon must not overlap, must not have gaps, must not overlap with, must be covered by feature class of, must cover each other, must be covered by, boundary must be covered by, area boundary must be covered by boundary of, and contains point.
2. Line must not overlap, must not intersect, must not have dangles, must not have pseudo-nodes, must not intersect or touch interior, must not overlap with, must be covered by feature class of, must be covered by boundary of, endpoint must be covered by, must not self overlap, must not self intersect, and must be single part.
3. Point must be covered by boundary of, must be properly inside polygons, must be covered by endpoint of, and must be covered by line.

Que 4.17. Discuss the data quality of GIS.

Answer

Data Quality of GIS :

1. Flaws in data are usually referred to as errors. Error is the physical difference between the real world and the GIS facsimile. Errors may be single, definable departures from reality, or may be persistent, widespread deviations throughout a whole database.
2. Accuracy is the extent to which an estimated data value approaches its true value. If a GIS database is accurate, it is a true representation of reality. It is impossible for a GIS database to be 100 % accurate, though it is possible to have data that are accurate to within specified tolerances.
3. Precision is the recorded level of detail of the data. A co-ordinate in metres to the nearest ten decimal places is more precise than one specified to the nearest three decimal places. Computers store data with a high level of precision, though a high level of precision does not imply a high level of accuracy.
4. Resolution is the term used to describe the smallest feature in a data set that can be displayed or mapped. In raster GIS, resolution is determined by cell size. For example, for a raster data set with a 20 m cell size, only those features that are 20 m × 20 m or larger can be distinguished. At

this resolution it is possible to map large features such as fields, lakes and urban areas but not individual trees or telegraph poles.

5. Generalization is the process of simplifying the complexities of the real world to produce scale models and maps. Cartographic generalization is a subject in itself and is the cause of many errors in GIS data derived from maps. It is the subjective process by which the cartographer selectively removes the enormous detail of the real world in order to make it understandable and attractive in map form.

6. **Completeness :** A complete data set covers the study area and the time period of interest in its entirety. The data should be complete spatially and temporally, and should have a complete set of attribute information.

7. Compatibility data sets can be used together sensibly. With GIS it is possible to overlay two maps, one originally mapped at scale of 1:500000 and the other at 1:25000. The result, however, is largely worthless because of incompatibility between the scales of the source documents.

8. Consistency applies not only to separate data sets but also within individual data sets. Inconsistencies can occur within data sets where sections have come from different source documents or have been digitized by different people. This will cause spatial variation in the error characteristics of the final data layer.

VERY IMPORTANT QUESTIONS

Following questions are very important. These questions may be asked in your SESSIONALS as well as UNIVERSITY EXAMINATION.

Q. 1. Explain vector data model.

Ans. Refer Q. 4.2, Unit-4.

Q. 2. What are the three basic spatial entities and how are these used to portray geographical features on paper maps and in GIS ?

Ans. Refer Q. 4.3, Unit-4.

Q. 3. What is topology and why it is important in GIS ?

Ans. Refer Q. 4.4, Unit-4.

Q. 4. What are the advantages and disadvantages of vector data over raster data ?

Ans. Refer Q. 4.9, Unit-4.

Q. 5. Explain how data can be converted from vector to raster format.

Ans. Refer Q. 4.10, Unit-4.

Q. 6. What is a data model ? Explain the data models used in GIS.

Ans. Refer Q. 4.12, Unit-4.

Q. 7. What is the difference between the object-based and field-based data models ?

Ans. Refer Q. 4.13, Unit-4.

5
UNIT

Raster Data Model

CONTENTS

PART-1

Raster Data Model, Elements of Raster Data Model, Types of Raster Data, Raster Data Structure, Data Conversion.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 5.1. Define the raster data model. What are the elements of raster data model ?

Answer

A. Raster Data Model :

1. The raster data model divides the geographic space into a regular grid of cells in specific sequence (row-column structure).
2. As in a traditional raster image, the X-axis is the column indicator and the Y-axis is the row indicator.
3. Not only geographic data, but other pictorial data can also be represented and stored in a computer as raster. For example, a digital photograph of one's pet; this is not a geographic or geospatial data but a raster.
4. For this reason, raster images representing geographically referenced spatial data are named as georaster by some people.
5. Raster data are also referred to as raster image. The cells which make a raster can be compared with the pixels. Each cell in the raster contains a single value. This value can be a reference to another value, but the idea is that each cell has just a single value, and it is assumed that the value is distributed evenly throughout the cell.
6. The raster cell size is an important factor. Smaller cell improve data quality because they can provide more detail. As cell size increases, data definition decreases or blurs.
7. Conceptually, raster models are the simplest of available spatial data models. We can create a raster of elevation values by encoding each cell with a value that represents the elevation which best represents the elevation in that cell's area.

B. Elements of Raster Data Model : Following are the 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.

Que 5.2. Describe the different types of raster data.

Answer

Types of Raster Data : Following are the types of raster data :

1. Satellite Imagery :

i. Remotely sensed satellite data are recorded in raster format.

ii. The pixel value in a satellite image represents light energy reflected or emitted from the Earth's surface.

iii. Land use, land cover and hydrography can be classified from image processing system.

iv. Satellite images can be displayed in black and white or in colour.

2. Digital Elevation Models (DEMs) :

i. DEM consists of an array of uniformly spaced elevation data.

ii. DEM is produced from :

   a. A stereo-plotter and aerial photograph with overlapping areas.

   b. Satellite imagery such as SPOT stereo-model using special software.

3. Digital Orthophotos :

i. Prepared from aerial photograph or other remotely sensed data.

ii. Displacement caused by camera tilt and terrain relief has been removed.

iii. They are geo-referenced and can be registered with topographic and other maps.

4. Binary Scanned Files :

i. Scanned image containing values of 1 and 0.

ii. Maps to be digitized are typically scanned at 300 or 400 dpi (dots per inch).

5. Graphic Files : Maps, photographs and images can be stored as digital graphic files.

i. TIFF (Tagged Image File Format), GIF Graphic Interchangeable Format), JPEG (Joint Photographic Exports Group), etc., are the graphic files.

ii. Geo-TIFF is a geo-referenced version of TIFF format.

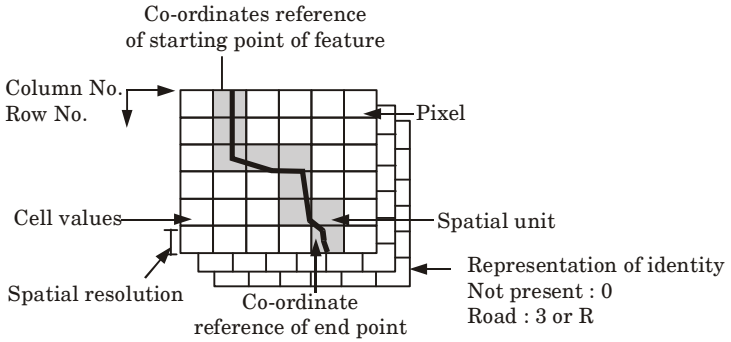
Que 5.3. Describe the raster data structures.

Answer

Raster Data Structures :

1. Raster data structures are also called cellular data structures depicts the real world by pixels or grid cells.
2. It is not an accurate or flexible as the vector format, as each co-ordinate may be represented by a cell and each line by an array of cells.
3. Raster data can be positioned only on the nearest grid cell. Examples of data in the raster format are aerial photographs, satellite imagery and scanned maps or plans.
4. Examples of data in the raster format are aerial photographs, satellite imagery and scanned maps or plans.
5. For the input of raster data, first the region of interest is sub-divided into a network of cells of uniform size and shape.
6. The linear dimensions of each cell define the spatial resolution of data or the precision with which the data is represented. Thus, the size of an individual pixel or cell is determined by the size of the smallest object in the geographic space to be represented.
7. A general rule is that the grid size should be less than half the size of the MMU.
8. Once the grid cell size has been decided, each grid cell is assigned a value which can be an integer, a floating point number, or a character.
9. A raster data along with characteristics is shown in Fig. 5.3.1. The values marked indicate the quantity, or characteristics of the spatial object, or phenomenon that is found at the location of the cell.

10. The input of the vector counter parts of this raster data is also shown in Fig. 5.3.1. The value 3 has been to classify the raster cells according to land use for the road at the given location.
11. The remaining cells are filled with 0 indicating that no identity is present at that location.
12. There are four methods for the input of the vector counter parts of the raster data. These are the dominant method, the precedence method, the presence/absence method and the percent occurrence method.



(a) Different attributes stored in different layer

0	3	0	0	0	0
0	3	0	0	0	0
0	3	3	3	0	0
0	0	0	3	0	0
0	0	0	3	3	0
0	0	0	0	3	0

(b) Cell values

6, 6, 3

0	3	0	0	0	0
0	3	0	0	0	0
0	3	3	3	0	0
0	0	0	3	0	0
0	0	0	3	3	0
0	0	0	0	3	0

(c) File structure

Fig. 5.3.1. E-R diagram for University System.

Que 5.4. **Write are the functioning of raster model.**

Answer

Functioning of Raster Model : Following are the various types function of raster model :

1. The pixels are the result of computing the data through aerial photograph or throughout the satellite imaging.
2. The colours and tones of the image are computed by assigning the unique numerical codes.
3. The digital number (DN) values of each one of the pixel and a cell has only one DN.
4. At present eight bit data is used by the new software. It allows up to 256 number *i.e.*, from 0 to 255.

Que 5.5. Discuss the methods to represent the raster data.

Answer

Methods to Represent the Raster Data :

The raster data can be represented by four different methods (ways) :

A. Real World Model : It is associated with specific real-world models, to represent the real world.

B. Image Scanning : It has the digital scans of maps and drawings, which is created with the methods of compilation.

C. Digital Satellite Data : It does the compilation of the digital satellite image data.

D. Drawing : By using the raster output unit the automatic drawing is presented :

i. In this model, the reality is represented by regular, uniform, square or rectangular cells. The squares, look like grid of squares. So they are also called as 'a grid model'.

ii. The cells are identified in rows and columns (location is expected of any cell by column and row numbers.

iii. The 'zero' row and column is at the upper left of the raster grid (this location is defined in different ways in different software's.

iv. These cells represent 'area' and not a point on the earth surface, so they are not to be used for giving precise measurement.

v. By giving the real surface values to the pixels, the model is produced. These values are comprised of the attribute objects which are represented by the cells.

vi. Any single cell is assigned only one single value, so the dissimilar objects are assigned to different raster layers.

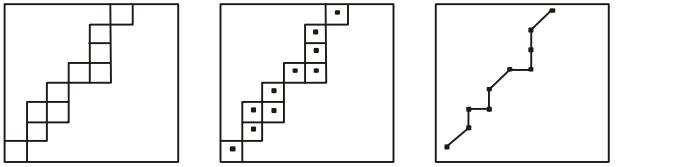
vii. Each of these layers represents a group of objects, with a specific theme like settlement or gross land or water bodies etc. Because the raw and column numbers are fixed, the location of neighbouring cells can be calculated very easily.

Que 5.6. **Write a short note on data conversion.**

Answer

Raster to Vector Conversion :

1. In this conversion, the cells of the raster through which the vector line (e.g., river, boundaries of buildings, roads, etc.) passes are identified.
2. Then the line (vector form) connecting these cells is drawn.
3. One way is to connect the centres of cells with straight line segments.
4. Obviously, this will produce a zig-zag line, whereas in nature this line would be a smooth one.
5. So, either curve-fitting is required or the cell size is to be reduced to extract/draw a smooth line passing through the cells.
6. The first method involves complicated mathematical calculations, which does not necessarily give a unique solution.
7. Either of the methods would require large capacity computers as well as time.
8. Even after this, the line drawn, using raster data, may not exactly match with the actual feature present in nature.
9. This conversion of data from raster to vector model is illustrated in Fig. 5.6.1.



(a) Cells of Fig. 1 that identify the river

(b) Cell centres

(c) Vector representation of river recreated by connecting adjacent cell centers

Fig. 5.6.1. Raster to vector conversion.

10. In case if the vector data is converted to raster data and then again converted back to the vector data, the resultant data set will not likely match with the original one. This is specifically true in case of boundaries of different common data or linear features.

PART-2

Integration of Raster and Vector Data : Data Input : Meta-data : Conversion of Existing Data, Creating New Data, Remote Sensing Data, Field Data, Digitizing, Scanning on Screen Digitizing, Importance of Source Map, Data Editing.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 5.7. Write a short note on Integration of raster and vector data.

Answer

Integration of Raster and Vector Data :

1. The major impediment for integration of remote sensing with GIS remains the so-called raster/vector dichotomy.
2. Remote sensing has been oriented almost completely towards a raster approach to data and analysis, while GIS software has tended to be vector oriented.
3. From the perspective of GIS users, it is recognized that there are advantages and disadvantages to both data representations.
4. Remote sensing users, on the other hand, while recognizing the merits of vector information for handling cartographic information, have concentrated largely on raster analysis for image processing.
5. There are good reasons for this the CPU processing burden for image analysis is sufficiently high that raster data structures are the only feasible choice on low-speed hardware platform.
6. Furthermore, since detectors produce raster digital information directly, raster processing seems "natural".

7. More generally, research on human vision and perception has led to a model of spatial information extraction, object recognition, and predicate manipulation that is constructed as a three level integrated raster-vector processing system.

Que 5.8. What are the uses of raster data model ?

Answer

Uses of Raster Data Model : Following are the uses of raster data model :

1. Geographical variation in the real world is infinitely complex.
2. The closer you look the more detail you see, almost without limit.
3. It would take an infinitely large database to capture the real world precisely.
4. Raster grid cells allow us to approximate the variation over a landscape.
5. Data must somehow be reduced to a finite and manageable quantity by a process of generalization or abstraction.
6. Geographical variation must be represented in terms of discrete elements or objects.

Que 5.9. What are the advantages and disadvantage of raster data model ?

Answer

1. Advantages : Following are the advantages of raster data model :

i. Simple data structure.

ii. Spatial analysis is easier.

iii. Compatible with remote sensing imagery.

iv. Simulation is easy because each unit has the same size and shape.

2. Disadvantages :

i. The cell size determines the resolution at which the data is represented.

ii. Require a lot of storage space.

iii. Projection transformations are time consuming.

iv. Network linkages are difficult to establish.

Que 5.10. What do you understand by existing GIS data and their conversion ?

Answer

A. Existing GIS Data :

1. To find existing GIS data for a project is often a matter of knowledge, experience and luck.
2. Since the early 1990s, government agencies at different levels in the US as well as other countries have set up websites for sharing pubic data.
3. The Internet is also a medium for finding existing data from NPO and private companies.

B. Conversion of Existing GIS Data :

1. Data conversion is defined as a mechanism for converting GIS data from one format to another.
2. It can be easy or difficult; it depends upon the specialty of the data formats :

i. Proprietary data formats require special translators for data conversion.

ii. Whereas neutral or public formats require a GIS package that has translators to work with the formats.

Que 5.11. Explain the types of conversion of existing GIS data.

Answer

Types of Conversion of Existing Data : Basically two types of convert process are used for conversion of any existing GIS data :

A. Direct Translation :

1. It uses a translator in a GIS package to directly convert geospatial data from one format to another. It is easier to use than other methods.
2. ArcToolbox in ArcGIS can Translate :

i. Arclnfo's interchange files >b – AutoCAD's DXF.

ii. DWG files and Maplnfo files into shapefiles or geodatabases.

Likewise, GeoMedia can access and integrate data from :

a. ArcGIS.

b. AutoCAD.

c. Maplnfo etc.

B. Neutral Format :

1. It is a public format for data exchange :

i. DLG format developed by USGS.

ii. SDTS format approved by the Federal Information Processing Standards (FIPS) Program in 1992. Also known as SDTS/DLG files.

iii. ESRI, Intergraph and Maplnfo provide translators in their software packages for importing SDTS data.

2. Currently there are five SDTS profiles :

i. The Topographical Vector Profile (TVP) covers DLG, TIGER and other topology-based vector data.

ii. The Raster Profile and Extensions (RPE) accommodate DEM and other raster data.

iii. The Transportation Network Policy (TNP) comes with vector data with network topology.

iv. The Point Profile supports geodetic control point data.

v. The Computer Aided Design and Drafting Profile (CADD).

vi. Supports vector-based CADD data, with or without topology.

Que 5.12. What do you mean by remote sensing data ?

Answer

Remote Sensing Data :

1. Remote sensors collect data by detecting the energy that is reflected from Earth. These sensors can be on satellites or mounted on aircraft.

2. Remote sensors can be either passive or active. Passive sensors respond to external stimuli.

3. They record natural energy that is reflected or emitted from the Earth's surface.

4. The most common source of radiation detected by passive sensors is reflected sunlight.

5. In contrast, active sensors use internal stimuli to collect data about Earth.

6. For example, a laser-beam remote sensing system projects a laser onto the surface of Earth and measures the time that it takes for the laser to reflect back to its sensor.

Que 5.13. Describe the digitizing in GIS.

Answer

Digitizing in GIS :

1. Digitizing is the process by which co-ordinates from a map, image, or other sources of data are converted into a digital format in a GIS.
2. This process becomes necessary when available data is gathered in formats that cannot be immediately integrated with other GIS data.

The Digitizing Process : Following are the digitizing process :

1. **Manual Digitizing :**

i. In this method, the digitizer uses a digitizing tablet (also known as a digitizer, graphics tablet, or touch tablet) to trace the points, lines and polygons of a hard-copy map.

ii. This is done using a special magnetic pen, or stylus, that feeds information into a computer to create an identical, digital map.

iii. Some tablets use a mouse-like tool, called a puck, instead of a stylus.

iv. The puck has a small window with cross-hairs which allows for greater precision and pinpointing map features.

2. Heads-up Digitizing :

i. This method involves scanning a map or image into a computer.

ii. The digitizer then traces the points, lines and polygons using digitizing software.

iii. This method of digitizing has been named "heads-up" digitizing because the focus of the user is up on the screen, rather than down on a digitizing tablet.

Que 5.14. Write a note on data acquisition. What are the various sources from which data can be derived to be used in GIS ?

Answer

Data Acquisition :

1. Data acquisition is collecting spatial data from available resources e.g., maps, photographic images and converting it into digital form.

2. Data which is already in digital form can be recorded directly.
3. The method for acquisition of data depends on factors such as location, size of area of interest, the purpose of terrain modeling and the technical resources available.

Sources : Data can be acquired from any of the following sources :

1. Data from Satellites Remote Sensing :

i. The terrain data acquired through sensors, abroad satellite platforms being in digital format can be directly used, and processed, for preparing a GIS database.

ii. This data is coded in picture elements called pixels and stored in the form of a two dimensional matrix, that contains merely a number representing the amount of the reflected EM radiation received in a band.

iii. The digital images must be located properly with respect to a geodetic grid, otherwise the data they contain, cannot be related to their true ground positions.

iv. Suitable for large areas.

2. Digital Data by GPS :

i. GPS is a satellite based surveying system which gives highly accurate digital terrain data electronically in the form of (x, y, z) co-ordinates.

ii. There are two methods of GPS measurements (i) Static (ii) Differential.

iii. Static GPS is mainly employed for establishing geodetic control and measuring national and international networks and not for ordinary terrain data acquisition.

iv. Differential GPS surveying is used to determine the positions and heights of ground points by making use of existing or newly established control points.

v. Differential GPS surveying may be performed as a kinematic GPS surveying or real time GPS surveying.

vi. GPS is a very productive tool for acquiring digital terrain data in field where the necessary is available and sky is visible.

3. Data from Internet (World-Wide Web) :

i. Internet is a vast network of digital computers which are linked together through a satellite and radio links and fibre optic, different data transmission media e.g., telephone lines through which transfer of terrain data is carried out.

ii. WWW (World Wide Web) is a term used synonymously with the internet.

iii. For GIS users the WWW provides data and is source of information.

iv. Whole libraries of vector, raster and object data are being offered on the internet as well as directory information on different data sets. At the moment speed of data transmission and internet access are the main limitations of this data source.

4. Data by Aerial Photography :

i. This method is used when area is too extensive and too rugged.

ii. A digital photogrammetric work station (DPWS) which produces digital images include the hardware, software and peripherals such as digital camera, film scanners, plotters. In it the plotter is able to visualize, verify and edit the data collected interactively.

iii. Digital terrain data can be collected from photogrammetry by using an analog stereoplotter equipped with encoders, analytical plotter or by using digital photogrammetry method.

iv. Analog stereoplotter provides 3 dimensional data from aerial photographs.

5. Data from Existing Maps :

i. Acquiring digital data by digitizing existing maps is comparatively cheaper and less time consuming.

ii. Topographic maps covering large part of a country are mostly available.

iii. Geocoding is the process of converting conventional (non-digital) maps into digital form.

iv. The digitisation of paper maps is done using a spatial data capturing device called "a digitizer". Digitizers are available in different sizes with different resolutions.

v. Another method of converting existing maps into digitised maps is by scanning and vectorisation often referred as "screen digitising" or "heads up digitising". Large number of maps can be digitised in relative shorter period and at a cost comparable or lower than the convention method.

6. Data by Surveying in Field :

i. Terrain data in digital form can be obtained directly from field surveys using electronic tacheometer, total stations.

ii. These instruments are equipped with internal memory or external data recorder for temporary storage of data, which are subsequently transferred to micro computer or main frame computer.

iii. Electronic tacheometer or total station is capable of electronically measuring angles, distances and performing computations to obtain horizontal distance, slope distance, difference in elevation, co-ordinates etc.

Que 5.15. Write a short note on data editing of raster data ?

Answer

Raster data editing is concerned with correcting the specific contents of raster images than their general geometric characteristics. The objective of the editing is to produce an image suitable for raster geo-processing. Following editing functions are mostly used for raster data editing :

i. **Filling Holes and Gaps :** To fill holes and gaps that appears in the raster image.

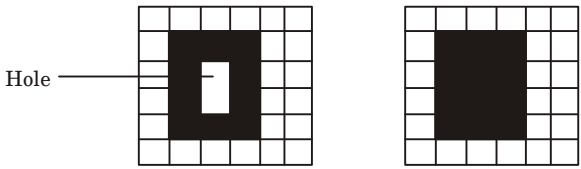


Fig. 5.15.1.

ii. **Edge Smoothing :** To remove or fill single pixel irregularities in the foreground pixels and background pixels along lines.

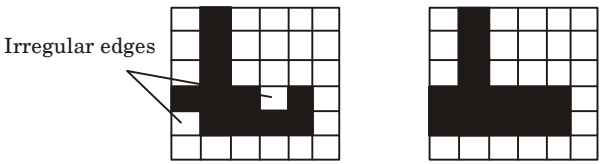


Fig. 5.15.2.

iii. **Deskewing :** To rotate the image by a small angle so that it is aligned orthogonally to the x and y axes of the computer screen.

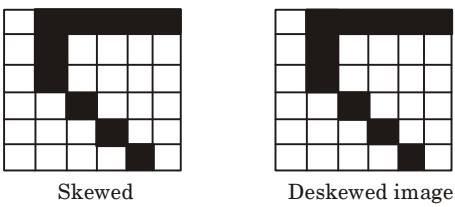


Fig. 5.15.3.

iv. **Filtering :** To remove speckles or the random high or low valued pixels in the image.

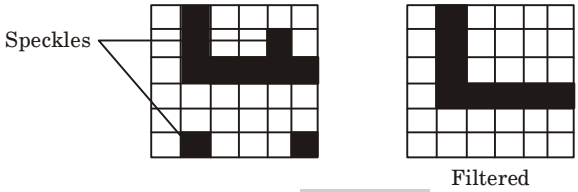


Fig. 5.15.4.

v. **Clipping and Delete :** To create a subset of an image or to remove unwanted pixels.

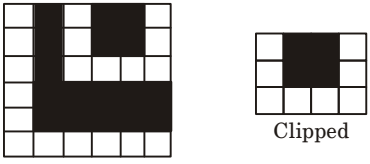


Fig. 5.15.5.

Que 5.16. What are the applications of GIS ?

Answer

Major application areas of GIS as follows :

Academic :	i. Research in engineering, science and humanities.
	ii. Primary and secondary schools—schools district delineation, facilities, management, bus routing, spatial digital libraries.
Industry :	i. Engineering—surveying and mapping, site and landscape development, pavement management.
	ii. Transportation—route selection for goods delivery, public transit, vehicle tracking.
	iii. Utilities and communications—electricity and gas distribution, pipelines telecommunication networks.
	iv. Forestry—forest resource inventory, harvest planning, wildlife management and conservation.
	v. Mining and mineral exploration.
	vi. System consulting and integration.

Business :	i. Banking and insurance.
	ii. Real estate—development project planning and management, sales and renting services, building management.
	iii. Retail and market analysis.
	iv. Delivery of goods and services.
Government :	i. Central government—national topographic mapping, resource and environmental management, weather services, public land management, population census, election, and voting.
	ii. State government—surveying and mapping, land and resources management, highway planning and management.
	iii. Local/municipal government—social and community development, land registration and property assessment, water and wastewater services.
	iv. Public safety and law enforcement—crime analysis, deployment of human resources, community policing, emergency planning and management.
	v. Health care.
	vi. International development and humanitarian relief.
Military :	i. Training.
	ii. Command and control.
	iii. Intelligence gathering.

VERY IMPORTANT QUESTIONS

Following questions are very important. These questions may be asked in your SESSIONALS as well as UNIVERSITY EXAMINATION.

Q. 1. Describe the different types of raster data.
Ans. Refer Q. 5.2, Unit-5.

Q. 2. Write are the functioning of raster model.
Ans. Refer Q. 5.4, Unit-5.

Q. 3. Write a short note on data conversion.
Ans. Refer Q. 5.6, Unit-5.

Q. 4. What are the advantages and disadvantage of raster data model ?
Ans. Refer Q. 5.9, Unit-5.

Q. 5. Write a note on data acquisition. What are the various sources from which data can be derived to be used in GIS ?
Ans. Refer Q. 5.14, Unit-5.

Q. 6. What are the applications of GIS ?
Ans. Refer Q. 5.16, Unit-5.

1 UNIT

Photogrammetry (2 Marks Questions)

1.1. Explain stereoscopy.

Ans. Stereoscopy is a technique for creating or enhancing the illusion of depth in an image by means of stereoscope for binocular vision.

1.2. Define the term 'stereoscope'.

Ans. To apply the principle of depth perception to aerial photographs, an instrument is used known as stereoscope. A stereoscope is a device for viewing a stereoscopic pair of separate images, depicting left-eye and right-eye views of the same scene, as a single 3D image.

1.3. How aerial photographs are taken ?

Ans. Aerial photographs are taken with the help of camera mounted on aircraft, flying along predetermined lines called flight lines and at predetermined height generally at regular interval.

1.4. What is flight planning ?

Ans. Flight planning is the process of producing a flight plan to describe a proposed aircraft flight. It involves two safety critical aspects : fuel calculation and compliance with air traffic control requirements.

1.5. Define aerial survey.

Ans. Aerial survey is a method of collecting geomatics or other imagery by using air planes, helicopters, UAVs, balloons or other aerial methods.

1.6. Mention the different types of aerial survey.

Ans. Following are the types of aerial survey :

i. Terrestrial photography.
ii. Aerial photography.

1.7. What are the different types of aerial photograph ?

Ans. Aerial photograph is divided, depending upon the angle between the axis of camera and the vertical axis, as follows :

i. Vertical photograph.
ii. Tilted photograph.

iii. Oblique photograph.
iv. Convergent photograph.
v. Trimetrogon photograph.

1.8. Define terrestrial photograph.

Ans. It is the photograph taken from ground station. The instrument used is phototheodolite which is a theodolite mounted on a camera with its axis horizontal or nearly horizontal.

1.9. What is vertical photograph ?

Ans. It is a one, in which the optical axis of the camera is vertical or nearly vertical. A truly vertical photograph resembles a map, through a vertical photograph can be rarely obtained.

1.10. Give any three advantages that aerial photography offers over ground based observations.

Ans. Following are the advantages of aerial photography :
i. Inaccessible areas.
ii. Mountainous region with less vegetation.
iii. Mapping large areas is faster and economical.

1.11. What are the disadvantages of aerial photography ?

Ans. Following are the disadvantages of aerial photography :
i. Not economical for survey of small areas.
ii. Not suitable for dense forests and flat sands due to difficulty of identifying objects upon the photograph.

1.12. Define fiducial marks.

Ans. To provide reference lines for the measurement of image distances, four marks are provided at the corners. These are called fiducial marks.

1.13. What is fiducial lines ?

Ans. The lines joining the opposite fiducial marks are called fiducial lines.

1.14. Define azimuth.

Ans. It is the horizontal angle measured in clockwise direction from north meridian to the principal plane. It is also called azimuth of the photograph.

1.15. What do you mean by relief displacement ?

Ans. The displacement on a photograph between the image of any ground point and its image, if the point is projected to a datum plane is the displacement caused by the topographic relief or elevation and is called relief displacement.

1.16. Explain parallax.

Ans. Parallax is a displacement or difference in the apparent position of an object viewed along two different lines of sight, and is measured by the angle or semi-angle of inclination between those two lines.

1.17. What is the use of parallax bar ?

Ans. It is used to measure the parallax difference between two points. The difference in parallax of two points is called parallax difference.

1.18. What are the advantages of digital photogrammetry ?

Ans. Following are the advantages of digital photogrammetry :

i. It facilitates direct production of digital maps.

ii. It can handle inputs from other non-traditional sources such as LIDAR, digital camera output, etc.

iii. It does not require any periodic maintenance except in two types of instruments.

2 UNIT

Remote Sensing (2 Marks Questions)

2.1. What do you understand by remote sensing ?

Ans. Remote sensing is the process of acquiring information about an object, area or phenomenon without coming in contact of it. Aerial photography is also called remote sensing.

2.2. Which type of energy is used in remote sensing ?

Ans. Electromagnetic energy, *i.e.*, light energy is used for remote sensing.

2.3. What is spectral signature ?

Ans. The patterns are averaged to get general reflectance characteristics of the object over different wavelength intervals. Representation of such averaged reflectance is called spectral signature.

2.4. What is resolution of a sensor ?

Ans. Resolution is the ability of remote sensing system to record information of the smallest clearly separable quantity in terms of size (spatial), wavelength band of electromagnetic radiation (spectral), radiation strength, and time.

2.5. Mention the types of resolution.

Ans. Following are the types of resolution :

i. Spatial resolution.
ii. Spectral resolution.
iii. Radiometric resolution.
iv. Temporal resolution.

2.6. Classify satellites.

Ans. The satellites can be divided into two categories :

i. Geo-stationary satellites (Geo-synchronous satellites).
ii. Sun-synchronous satellites.

2.7. How will you define an orbit ?

Ans. It is the path followed by a satellite in space. It can be circular or elliptical. Orbit can vary in terms of altitude, their orientation/ inclination in relation to the Earth.

2.8. What are the characteristics of ideal remote sensing system ?

Ans. Following are the characteristics of ideal remote sensing system :

i. Uniform electromagnetic energy source.
ii. Series of unique energy.
iii. Non-interfering atmosphere.
iv. Super sensor.

2.9. Discuss the data products which are used in remote sensing.

Ans. Following are the uses of data product in remote sensing :

i. Photographs. ii. Mosaics.
iii. Orthophoto. iv. Digital image.

2.10. Give classification of selective scattering.

Ans. Following are the two types of scattering :

i. Rayleigh scattering. ii. Mie scattering.

2.11. Differentiate the active and passive sensors.

Ans.

S. No.	Active Sensors	Passive Sensors
i.	Sensors which produce their own electromagnetic energy of specific wavelength.	Sensors which do not produce their own electromagnetic energy but sense natural radiations are passive sensors.
ii.	**Example :** Flash photography, radar, etc.	**Example :** Available light photography sensing during bright sunlight.

2.12. What is geo-synchronous satellite ?

Ans. A geo-synchronous satellite is a satellite in geo-synchronous orbit, with an orbital period the same as the Earth's rotation period. Such a satellite returns to the same position in the sky after each sidereal day, and over the course of a day traces out a path in the sky that is typically some form of analemma.

2.13. What is sun-synchronous satellite ?

Ans. A sun-synchronous satellite is a satellite in sun-synchronous orbit (SSO), travelling over the polar regions, are synchronous with sun. This means they are synchronised to always be in the same 'fixed' position relative to the sun.

2.14. Distinguish between a camera and a sensor.

Ans.

S. No.	Camera	Sensor
i.	Simple construction.	Complex construction.
ii.	It can be ground borne, air borne or space borne platforms.	It is generally space borne platforms.
iii.	Framing system.	Scanning system.

2.15. Give the applications of Indian Remote Sensing (IRS).

Ans. **Application :** Imagery taken by Indian Remote Sensing (IRS) satellite has found application in diverse fields ranging from agriculture to urban planning.

Example : Crop health monitoring, Crop yield estimation and drought assessment.

2.16. Differentiate the active and passive remote sensing system.

OR

What do you mean by active and passive remote sensing ?

Ans.

S. No.	Active RSS	Passive RSS
1.	It generates and uses its own energy to illuminate the target and records the reflected energy.	They depend on solar radiation to illuminate the target.
2.	These systems operate in the microwave region of the electromagnetic spectrum.	They operate in the visible and infrared region of the electromagnetic spectrum.
3.	Their wavelengths are longer than one mm.	Their wavelengths range from 0.4 to 10 μm.
4.	**Example :** Synthetic aperture radar.	**Example :** Any electromagnetic remote sensing system (Camera without flash light).

2.17. Define spectral reflectance curve and what are its utilities in remote sensing. **AKTU 2015-16, Marks 02**

OR

Explain spectral reflectance curve.

AKTU 2016-17, Marks 02

Ans. **Spectral Reflectance Curve :** It is a graph between spectral reflectance of an object versus wavelength.

Utilities : Spectral reflectance curves are used to compare the aerial photograph taken with them to assess what feature exists at any location in an aerial photograph.

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3 UNIT

GIS and Advance Remote Sensing (2 Marks Questions)

3.1. Define the term 'GIS'.

Ans. GIS is a system of hardware, software, and procedures designed to support the capture management, manipulation, analysis, modeling and display of spatially referenced data for solving complex planning and management problems.

3.2. What is database ?

Ans. It is a collection of data regarding different objects, phenomenon, themes, etc.

3.3. Discuss about thematic maps.

Ans. These are the maps which show one theme e.g., natural resources, drainage system, water distribution system.

3.4. Discuss the advantages of GIS.

Ans. Following are the advantages of GIS :

i. GIS can handle spatially referenced, multi layered, heterogeneous huge data.

ii. GIS can process the data with high speed and produce output almost in no time and can answer allied queries related to the topic.

3.5. What are the components of GIS ?

Ans. Following are the types of component of GIS :

i. Hardware.

ii. Software.

iii. Procedure.

iv. Data.

v. Users.

3.6. What are grid cells ?

Ans. These are single elements, usually square, within a continuous geographic variable. Grid cells may be used to represent terrain slopes, soil types, land cover, etc.

3.7. Classify models in GIS.

Ans. Basically two types of models are :

i. Vector model.

ii. Raster model.

3.8. Enumerate the five basic spatial entities.

Ans. Following are the basic spatial entities :

i. Point.

ii. Line and string.

iii. Areal.

iv. Pixels.

v. Grid cells.

3.9. What are the hardware components of a GIS ?

Ans. Following are the hardware components of a GIS :

i. CPU : Central processing unit is linked to disk drive, which provides space for storing data and programs.

ii. Digitizer : It is a device used to convert data from maps and documents into digital form (Raster to vector).

iii. Plotter : Plotter is used to present the result of the data processing on a paper.

iv. Tape Drive : It is used to store data or programs on magnetic tape for communicating with other system.

v. VDU : (Visual Display Unit) It is used to control the computer and the other peripherals. It is otherwise known as terminal or workstation.

3.10. What are the different uses of GIS ?

Ans. The area of GIS applications are unlimited as it can be used for management and planning that may be required in any field, e.g., urban planning, forestry, environmental management, flood control, natural disaster management, etc.

3.11. How GIS helps in analyzing the earthquakes ?

Ans. For analyzing the earthquake, several readings are taken for that particular site, and also calculate the rock deformation characteristics of the site.

3.12. What are maps ?

Ans. A map is a set of points, lines and areas that are defined by their spatial location with respect to a co-ordinate system and by their non spatial attributes. A map legend links the non-spatial attributes to spatial attributes.

3.13. What is a projection ?

Ans.

i. A projection is a method by which the curved surface of the Earth is represented on a flat surface and it involved the use of mathematical locations on the plane.

ii. When the curved surface of the Earth is shown on a flat sheet, some distortion is inevitable.

iii. The distortion is least when the map only shows small areas and maximum when the map shows entire surface of the Earth.

3.14. What are the broad classifications of projections ?

Ans. Following are the classification of projections :

i. Equal Area Projections : They preserve the area of the features by assigning them an area on the map which is proportional to their area on the earth.

ii. Conformal Projections : They preserve the shapes of small features and show directions (bearings) covertly.

iii. Equidistant Projections : They preserve the distances of places from one or two points.

3.15. What are the projections, which find their importance in India ?

Ans. The following projections are of importance for mapping in India :

i. Polyconic projections.

ii. Lambert conformal conic projection.

iii. Transverse mercaptor projection.

iv. Universal transverse mercaptor projection.

v. Cassini projection.

4 UNIT

Vector Data Model (2 Marks Questions)

4.1. Define the vector data model.

Ans. The vector model is close to the traditional mapping approach where the objects are represented as points, lines, or areas.

4.2. What do you understand by spatial data model ?

Ans. It is a geographical representation of Earth features inter-connected by a co-ordinate system. Spatial data available on maps, photographs is not in digital form, is spatially located in digital format while integrating it in a GIS.

4.3. Describe the advantages of vector data.

Ans. Following are the advantages of vector data :

i. A point data can be positioned accurately.
ii. A line data can be represented in exact and fine detail.
iii. Vector data provides exact fine boundaries of aerial patterns e.g., land cover, etc.

4.4. Write the disadvantages of vector data.

Ans. Following are the disadvantages of vector data :

i. Vector formats prove costlier because of higher data encoding cost.
ii. Programs for data manipulation are more complex.
iii. Superimposing / overlaying different layers of data may be difficult.

4.5. Discuss the geospatial analysis.

Ans. Geospatial analysis is the gathering, display, and manipulation of imagery, GPS, satellite photography and historical data, described explicitly in terms of geographic coordinates or implicitly, in terms of street address, postal code, or forest stand identifier as they are applied to geographic models.

4.6. What is data acquisition ?

Ans. Data acquisition is collecting spatial data from available resources e.g., maps, photographic images and converting it into digital form. Data which is already in digital form can be recorded directly.

4.7. What is buffering ?

Ans. Buffering is the creation of polygons that surround other points, lines or polygons. Buffers may be created either to exclude a certain amount of area around a point, line or polygon or to include only the buffer area in a study.

4.8. What is reclassification ?

Ans. Reclassification is an important variation of the query idea in GIS and is used in place of a query in raster GIS. In raster GIS, the method of reclassification can be used in place of query to obtain information under search from a GIS database.

4.9. Differentiate GIS from an information system (IS) and CAD software ?

Ans.

S. No.	GIS	IS and CAD software
1.	GIS has the capabilities of analysis of spatial data.	IS and CAD software do not have the capabilities of handling spatial data.
2.	Complex analysis of multiple spatial data and non-spatial data in an integrated manner is possible.	It is not possible to use spatial data therefore obviously complex analysis involving spatial and non spatial data together is not possible.
3.	GIS may be raster based vector based or recently the advanced hybrid GIS is also available.	CAD software is compatible only with vector data structure. In an IS or CAD software raster data structures can not be used.

4.10. Describe attribute data.

Ans. Attribute data is data that have a quality characteristic (or attribute) that meets or does not meet product specification. These characteristics can be categorized and counted.
Examples of attribute data include sorting and counting the number of blemishes in a particular product (defects), and the number of non-conforming pieces (defectives).

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5 UNIT

Raster Data Model (2 Marks Questions)

5.1. Define the raster data structure.

Ans. Raster data structure, also called cellular data structure depicts the real world by pixels or grid cells.

5.2. How can you classify raster data ?

Ans. In the raster data structure, everything is represented by grid cells, a point is represented by a single cell, a line by a string of cells and an area by a group of cells.

5.3. Discuss the advantages of raster format.

Ans. Following are the advantages of raster format :

i. Raster formats do not prove to be so costly.
ii. Programs for data manipulation are simple.
iii. Ideally suitable for a variety of spatial analysis functions.

5.4. Explain the disadvantages of raster format.

Ans. Following are the disadvantages of raster format :

i. It cannot represent formats accurately as in case of vector data.
ii. A raster data base requires more storage space.
iii. Line data can be represented as zig-zag line, etc.

5.5. Distinguish between spatial and non-spatial data ?

Ans.

Spatial Data	Non-spatial Data
Data that define a location. These are in the form of graphic primitives that are usually either points, lines, polygons or pixels.	Data that relate to a specific, precisely defined location. The data are often statistical but may be text, images or multi-media. These are linked in the GIS to spatial data that define the location.

5.6. What are the data input devices used in a GIS ?

Ans. The important data input devices in a GIS are :

i. **Digitizer :** Conversion of raster to vector.
ii. **Scanner :** To convert data on paper to raster/digital data.
iii. **Keyboard :** Entry of attribute data.
iv. **Disk Drive :** To take data from another system into a GIS.

5.7. What are the data output devices used in GIS ?

Ans. The important data output devices used in a GIS are :

i **Plotter :** Used to plot the graphical information after analysis on a paper.
ii. **Printer :** Used to print the information after analysis on a paper.
iii. **VDU (Visual Display Unit) :** Used to display the results after analysis.
iv. **Tape Drive :** Used to store the results after analysis and take it to other systems.

5.8. What are the different input methods into a GIS ?

Ans. Following are the different input methods into a GIS :

i. Keyboard entry.
ii. Manual digitizing.
iii. Scanning and automatic digitizing.

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