CHAPTER 18

GIS, GPS & Remote Sensing

A. GIS (Geographical Information System)

18.1 Introduction

- GIS is a technological field that incorporates geographical features with tabular data in order to map, analyse, and assess real-world problems.
- In the strictest sense, a GIS is a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information, i.e. data identified according to their locations. Practitioners also regard the total GIS as including operating personnel and the data that go into the system.
- GIS can show many different kinds of data on one map. This enables people to more easily see, analyse, and understand patterns and relationships.
- With GIS technology, people can compare the locations of different things in order to discover how they relate to each other. For example, using GIS, the same map could include sites that produce pollution, such as gas stations, and sites that are sensitive to pollution, such as wetlands. Such a map would help people determine which wetlands are most at risk.

18.2 Development of GIS

- The first GIS was created by Dr. Roger Tomlinson and then introduced in the early 1960s in Canada.
- During its inception, this system was mainly meant for collecting, storing and then analysing the capability & potential which the land in the rural areas had.
- Prior to this, mapping by the use of computers was being used for such cases but this is a method that had numerous limitations associated to it.
- By the end of the 80s period, the use of GIS had already become popular in other related fields which is why it led to a spur in the growth of the industrial sector.
- Recently, designers came up with open source software for GIS so that this technology can be enhanced in a much simpler manner while being made available to all.

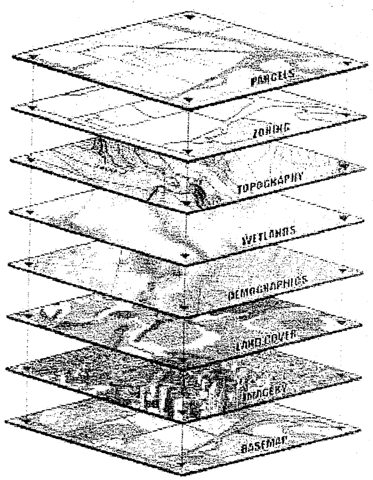
18.3 Importance of GIS

- GIS informs not only about the activities and the events but also where they exist.
- The solutions to problems often require access to several types of information that can only be linked by geography.
- GIS allows to store and manipulate information using geography and to analyze patterns, relationships, and trends in that information to help in making better decisions.

18.4 Components of GIS

The various components of GIS which work in synchronised manner with each other are:

- **Hardware:** Hardware comprises the equipment needed to support the many activities needed for geospatial analysis ranging from data collection to data analysis.
- **Software:** Different types of software are important. Central to this is the GIS application package. Such software is essential for creating, editing and analysing spatial and attribute data, therefore these packages contain a myriad of geospatial functions inherent to them.
- **Data:** Data is the core of any GIS. There are two primary types of data that are used in GIS: vector and raster data. Vector data is spatial data represented as points, lines and polygons. Raster data is cell-based data such as aerial imagery and digital elevation models. Coupled with this data is usually data known as attribute data. Attribute data generally defined as additional information about each spatial feature housed in tabular format.



GIS DATA LAYERS

Many different types of data can be integrated into a GIS and represented as a map layer.

Examples can include : streets, parcels, zoning, flood zones, client locations, competition, shopping centres, office parks, demographics, etc.

When these layers are drawn on top of one another, undetected spatial trends and relationships often emerge. This allows us to gain insight about relevant characteristics of a location.

Fig. 18.1

- **Procedures** : These include the methods or ways by which data has to be input in the system, retrieved, processed, transformed and presented.
- **People:** Well-trained GIS professionals knowledgeable in spatial analysis and skilled in using GIS software are essential to the GIS process.

18.5 Applications of GIS

There are numerous ways in which this technology can be used. The most common ones are:

- Management of resources
- Investigations of the earth's surface that is scientific in nature
- Archeological uses
- Planning of locations and management of assets
- Urban & regional planning
- Criminology matters
- An Impact assessment of the environment
- The assessment and eventual development of infrastructure
- Studies of the demographics of an area plus its population analysis with regards to engineering.

B. GPS (Global Positioning System)

18.6 Introduction

- The Global Positioning System (GPS) is a space-based navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.
- GPS is also known as the NAVSTAR (Navigation System for Timing and Ranging).
- It was developed by the United States' Department of Defence.
- As a military system, Navstar was originally designed and reserved for the sole use of the military but civilian users were allowed access in 1983. Back then, accuracy for civilian users was intentionally degraded to +/- 100m using a system known as Selective Availability (SA) but this was eliminated in May 2000.
- It consists of 24 satellites (21 + 3 active spares) nominally orbiting the Earth in MEO i.e. Medium Earth Orbit.
- The GPS system currently has 27 active satellites orbiting the Earth as new ones are replacing older ones.
- The satellites orbit about 20,000km from the earth's surface and make two orbits per day and repeat the same ground track everyday.
- The orbits are designed so that they ensure the availability of minimum 4 satellites whose visibility is above a 15 degrees cutoff angle anywhere on earth's surface irrespective of time of day.
- This enables GPS receivers to determine their current location, time and velocity. The GPS satellites are maintained by the United States Air Force.
- GPS works all across the world and in all weather conditions, thus helping users track locations, objects, and even individuals! GPS technology can be used by any person if they have a GPS receiver.

- A GPS receiver must be locked on to the signal of at least 3 satellites to calculate a 2-D position (latitude and longitude) and track movement.
- With four or more satellites in view, the receiver can determine the user's 3-D position (latitude, longitude and altitude).
- Once the user's position has been determined, the GPS unit can calculate other information, such as speed, bearing, track, trip distance, distance to destination, sunrise and sunset time and more.

18.7 Working of GPS

- Each GPS satellite transmits data that indicates its location and the current time.
- All GPS satellites synchronize operations so that these repeating signals are transmitted at the same instant.
- The signals, moving at the speed of light, arrive at a GPS receiver at slightly different times because some satellites are further away than others.
- The distance to the GPS satellites can be determined by estimating the amount of time it takes for their signals to reach the receiver.
- When the receiver estimates the distance to at least four GPS satellites, it can calculate its position in three dimensions.

18.8 Structure of GPS

- The GPS system comprises of three parts: Space segment, User segment and Control segment. The diagram of the structure of GPS is given below.

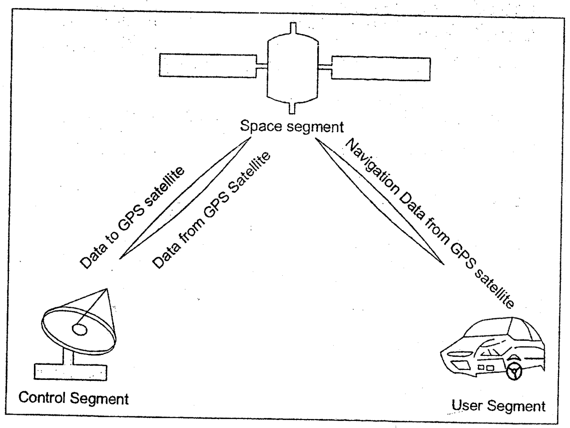


Fig. 18.2

- **Space segment:** The satellites are the heart of the Global positioning system which helps to locate the position by broadcasting the signal used by the receiver. The signals are blocked when they travel through buildings, mountains, and people. To calculate the position, the signals of four satellites should be locked. You need to keep moving around to get clear reception.
- **User segment:** This segment includes military and civilian users. It comprises of a sensitive receiver which can detect signals (power of the signal to be less than a quadrillionth power of a light bulb) and a computer to convert the data into useful information. GPS receiver helps to locate your own position but disallows you being tracked by someone else.
- **Control segment:** This helps the entire system to work efficiently. It is essential that the transmission signals have to be updated and the satellites should be kept in their appropriate orbits.

Advantages:

- Intervisibilily between different stations not required
- Not dependent on weather conditions, day or night.
- Positional accuracy irrespective of network geometry acts as a function for two or more different station distance.
- Homogeneous accuracy affects geodetic network planning and could easily establish point with the sites where stations are not visible e.g. mountains.
- Comparatively more flexible, consuming less time and also more effective.
- High accuracy with 3-dimensional geographic information irrespective of place and time.

Current Limitations of GPS:

- Clear and fine visibility of sky and no obstructions through any obstacles e.g. branches etc.
- Limited application in especially urban areas.
- Higher efficiency generally not needed
- GPS coordinates in WGS-84 datum not easily convertible into local geodetic system. It is only possible via reliable transformation scheme.
- Comparison of GPS accuracy and terrestrial accuracy could create confusion or conflict for many years which is yet to come.
- Not easily universally acceptable.
- Highly skilled workers.

18.9 Applications of GPS

Civilian Applications:

- Navigation – Used by navigators for position, orientation and precise velocity measurements.
- Geotagging – Map overlays can be created by applying location coordinates to photographs and other kind of documents.
- Surveying – Surveyors create maps and verify the boundaries of the property.
- Map-making – Used by civilians and military cartographers.
- Tectonics – Detect the direct false motion measurement in earthquakes.
- Geofencing – Vehicle, person or pet can be detected by using GPS vehicle tracking system, person tracking systems, and pet tracking systems.

Military Applications:

- Navigation – Soldiers can find objectives in the dark and unknown regions with the help of GPS.
- Search and Rescue – Knowing the position of a downed pilot, its location can be traced out easily.

- Reconnaissance – Patrol movement can be handled.
- Target tracking – Military weapon systems use GPS to track air targets and potential ground before they are flagged as hostile.
- GPS carry a set of nuclear detonation detectors (such as optical sensor, dosimeter, electromagnetic pulse sensor, X-ray sensor) which is a part of United States Nuclear Detonation Detection System.
- Missile and projectile guidance – Targets military weapons such as cruise missiles, precision – guided munitions.

C. Remote Sensing

18.10 Introduction

- Remote sensing is the science and art of acquisition of information about an object or phenomenon from a distance without making physical contact with them.
- Advantage of remote sensing is that a bird's eye perspective view can be captured from a considerable distance above the earth's surface and thus a very large area can be covered.
- The best example of remote sensing is the **human eye**.
- Human eye is able to see an object when light gets reflected from that object. Human eye acts as a sensor which detects the object by the image formation at the retina.
- But human eye is able to see only a small part of the electromagnetic spectrum called as **visible spectrum**.
- In modern usage, the term remote sensing generally refers to the use of aerial sensor technologies to detect and classify objects on Earth (both on the surface, and in the atmosphere and oceans) by means of electromagnetic energy (such as light, heat, microwave).
- Remote sensors collect data by detecting the energy that is reflected from Earth. These sensors can be on satellites or mounted on aircraft.
- In remote sensing, data is acquired from highly advanced cameras, multispectral scanners and radars etc. mounted on satellite or aircraft.
- Most of the real world remote sensing processes are electromagnetic type.
- Electromagnetic remote sensing involves the following basic elements:
  - **Source of energy** which provides the requisite electromagnetic energy to the object under consideration.
  - **Atmosphere** for propagating energy from the source to the object.
  - **Interaction with earth's surface** featrues which depends on the characteristics of the object and the incident energy.
  - **Receiving and recording** of energy by the sensors mounted on aircrafts, satellites etc.
  - **Processing of information** of the data received by the sensors.
  - **Interpretation and analysis** of processed information.

- Remote Sensing is broadly classified into two categories.

Table 18.1 *Difference between Passive and Active Remote Sensing*

Passive Remote Sensing	Active Remote Sensing
• Passive sensors respond to external stimuli. • They record natural energy that is reflected or emitted from the Earth's surface. The most common source of radiation detected by passive sensors is reflected sunlight. • Ex. RADAR - RAdio Detection And Ranging, and LiDAR (Light + RADAR).	• Active Remote Sensing • Active sensors use internal stimuli to collect data about Earth. • 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. • Ex. film photography, infrared, charge-coupled devices, and radiometers.

18.11 Electromagnetic Waves

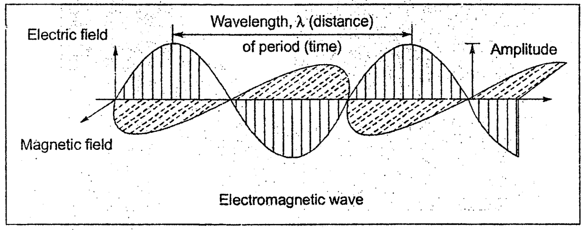


Fig. 18.3

An electromagnetic wave is a transverse wave in that the electric field and the magnetic field at any point and time in the wave are perpendicular to each other as well as to the direction of propagation.

- In free space, electromagnetic waves always propagate with the speed of light (3×10^8 m/s) independent of the speed of the observer or of the source of the waves.
- Electromagnetic radiation spans an enormous range of frequencies or wavelengths, as is shown by the electromagnetic spectrum.
- Customarily, it is designated by fields, waves, and particles in increasing magnitude of frequencies—radio waves, microwaves, infrared rays, visible light, ultraviolet light, X rays, and gamma rays. The corresponding wavelengths are inversely proportional, and both the frequency and wavelength scales are logarithmic.

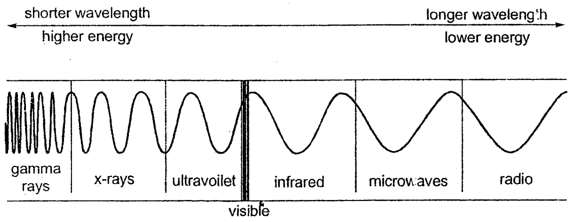


Fig. 18.4

- The boundaries between different waves of electromagnetic spectrum are not well defined and there is an overlap between them.

Table 18.2 *Usability of different electromagnetic waves for remote sensing*

Region Name	Wavelength	Comments
Gamma rays	< 0.03 nanometers	Entirely absorbed by the Earth's atmosphere and not available for remote sensing.
x-ray	0.03 to 30 nanometers	Entirely absorbed by the Earth's atmosphere and not available for remote sensing.
Ultravoilet	0.03 to 0.4 micrometers	Wavelengths from 0.03 to 0.3 micrometers absorbed by ozone in the Earth's atmosphere.
Photographic Ultravoilet	0.3 to 0.4 micrometers	Available for remote sensing the Earth. Can be imaged with cameras and sensors.
Visible	0.4 to 0.7 micrometers	Available for remote sensing the Earth. Can be imaged with cameras and sensors.
Near and mid Infrared	0.7 to 3.0 nanometers	Available for remote sensing the Earth. Can be imaged with cameras and sensors.
Thermal Infrared	<0.7 to 3.0 nanometers	Available for remote sensing the Earth. This wavelength cannot be captured by film cameras. Sensors are used to image this wavelength band.
Microwave or Radar	0.1 to 100 centimeters	Longer wavelengths of this band can pass through clouds, fog, and rain. Images using this band can be made with sensors that actively emit microwaves.
Radio	>100 centimeters	Not normally used for remote sensing the Earth.

- Table below shows major regions of electromagnetic spectrum and their uses.

Table 18.3 *Wave length regions and their applications in remote sensing*

Region	Wave length (µm)	Principal Applications
(a) Visible region		
1. Blue	0.45-0.52	Coastal morphology and sedimentation study, soil and vegetation differentiation, coniferous and deciduous vegetation discrimination.
2. Green	0.52-0.60	Vigour assessment, Rock and Soil discrimination, Turbidity and bathymetry studies.
3. Red	0.63-0.69	Plant species differentiation.
(b) Infrared region		
4. Near Infrared	0.76-0.90	Vegetation vigour, Bomass, delineation of water features, land forms/geomorphic studies.
5. Mild-infrared	1.55-1.75	Vegetation moisture content, soil moisture content, snot and cloud differentiation.
6. Mid-infrared	2.08-2.35	Differentiation of geological materials & Soils.
7. Thermal IR	3.0-5.0	For hot targets, i.e., Fires and volcanoes.
6. Thermal IR	10.4-12.5	Thermal sensing, vegetation discrimination, volcanic studies.

18.12 Scattering of Electromagnetic Radiation

- Scattering of electromagnetic radiation is caused by the interaction of radiation with matter resulting in the re-radiation of part of the energy to other directions not along the path of the incidint radiation.
- Scattering effectively removes energy from the incident beam. Unlike absorption, this energy is not lost, but is redistributed to other directions.
- Both the gaseous and aerosol components of the atmosphere cause scattering in the atmosphere.

Rayleigh scattering:

- It occurs when the size of the particle responsible for the scattering event is much smaller than the wavelength of the radiation.
- This type of scattering occurs due to gaseous molecules in upper part of atmosphere.
- The scattered light intensity is inversely proportional to the fourth power of the wavelength. Hence, blue light is scattered more than red light. This phenomenon explains why the sky is blue and why the setting sun is red.

Mie Scattering:

- If the size of the particle is similar to or larger than the radiation wavelength, the scattering is named Mie Scattering.
- This scattering occurs due to aerosol particles and depends on the shapes, sizes and the materials of the particles.

Non-selective scattering:

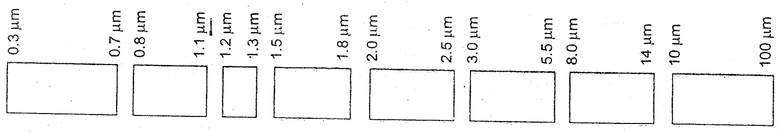
- The scattering of all wavelengths of electromagnetic radiation equally in the atmosphere, usually caused by particles which are much larger than the energy wavelengths.
- It occurs in the lower portion of the atmosphere. This type of scattering is not wavelength dependent and is the primary cause of haze.

Atmospheric Absorption:

- In contrast to scattering, atmospheric absorption results the effective loss of energy as a consequence of the attenuating nature of atmospheric constituents, like molecules of ozone, CO_2 and water vapour. Oxygen absorbs in the ultraviolet region and also has an absorption band centered on 6.3 µm. Similarly CO_2 prevents a number of wave length reaching the surface. Water vapour is an extremely important absorber of EM radiation within infrared part of the spectrum.

Atmospheric Windows:

- The amount of scattering or absorption depends upon (i) wave length and (ii) composition of the atmosphere. In order to minimise the effect of atmosphere, it is essential to choose the regions with high transmittance.
- The wavelengths at which EM radiations are partially or wholly transmitted through the atmosphere are known as atmospheric windows and are used to acquire remote sensing data.
- Typical atmospheric windows on the regions of EM radiation are shown in figure.



Atmospheric Windows

Fig. 18.5

- The sensors on remote sensing satellites must be designed in such a way as to obtain data within these well defined atmospheric windows.

18.13 Interaction of Elecromagnetic Radiation with Earth's Surface

- Electromagnetic radiation that passes through the earth's atmosphere without being absorbed or scattered reaches the earth's surface to interact in different ways with different materials constituting the surface.
- There are three ways in which the total incident energy will interact with earth's surface materials. These are
  - Absorption
  - Transmission, and
  - Reflection
- **Absorption (A)** occurs when radiation (energy) is absorbed into the target.
- **Transmission (T)** occurs when radiation passes through a target.
- **Reflection (R)** occurs when radiation "bounces" off the target and is redirected.
- How much of the energy is absorbed, transmitted or reflected by a material will depend upon:
  - Wavelength of the energy
  - Angle of incidence
  - Surface roughness
  - Material constituting the surface
  - Condition of the feature.
- Interaction with matter can change the following properties of incident radiation: (a) Intensity (b) Direction (c) Wave length (d) Polarisation and (e) Phase.

  The science of remote sensing detects and records these changes.

  The energy balance equation for radiation at a given wage length (λ) can be expressed as follows:

$$E_{I\lambda} = E_{R\lambda} + E_{A\lambda} + E_{T\lambda}$$

where $E_{I\lambda}$ = Incident energy

$E_{R\lambda}$ = Reflected energy

$E_{A\lambda}$ = Absorbed energy

$E_{T\lambda}$ = Transmitted energy

  The proportion of each fraction ($E_{R\lambda}/E_{A\lambda}/E_{T\lambda}$) will vary for different materials depending upon their composition and condition. Within a given features types, these proportions will vary at different wave length, thus helping a discrimination of different object.
- Reflection, scattering, emission are called surface phenomenon because these are determined by the properties of surface, viz. colour, roughness.
- Transmission and absorption are called volume phenomena because these are determined by the internal characteristics of the matter. viz., density and condition.

18.14 Remote Sensing Observation Platforms

- **Air Borne Platforms (Upto 50 m):** Air borne remote sensing was well known remote sensing method used in the initial years of development of remote sensing.
- Cameras tied to balloons and pigeons were used as Remote Sensing equipments in eighteenth and nineteenth century.
- Aircraft mounted systems were developed for military purposes during early part of twentieth century.
- In India, three types of Remote Sensing equipments are currently used:
  - Dakota
  - AVRO
  - Beach-craft Superking Air 200
- Remote Sensing equipments available in India are:
  - Multi-spectral scanner
  - Ocean colour radiometer
  - Aerial cameras for photography in B/W, colour and near infrared etc.
- Aircraft operations are very expensive and not suitable for continuous monitoring of constantly changing phenomenon like crop growth, vegetation cover, etc.
- Aircraft based platforms cannot provide cost and time effective solutions.
- **Space Based Platforms (Upto 50 km):** Space based platforms offer several advantages over air borne platforms such as:
  - They provide synoptic view.
  - Systematic and repetitive coverage.
  - Less affected by atmospheric drag
  - Orbits can be well defined.
- Different types of satellites used for Space based programs:
  - **Polar Orbiting Satellites:** Polar orbit is one in which a satellite passes above or nearly above both poles of the body on each revolution. It has an inclination of 90 degrees to the equator.
  - **Geo-Stationary Satellites:** These are the satellites which are stationary in reference to the earth. It's orbital period is same as the Earth's rotation period. Their altitude is about 36000 km.
  - **Landsat Satellite Programme:** It is the longest running enterprise for acquisition of satellite imagery of Earth. In July 1972, the Earth Resources Technology Satellite was launched. This was eventually renamed to Landsat.
  - **SPOT Satellite Programme:** France, Sweden and Belgium joined together to develop an Earth Observation Satellite system known as Satellite Pour l'Observation de la Terre meaning "Satellite for observation of Earth".
  - **Indian Remote Sensing Satellites:** Starting with IRS-1A in 1988, ISRO has launched many operational remote sensing satellites. Today, India has one of the largest constellations of remote sensing satellites in operation. Currently, eleven operational satellites are in orbit – RESOURCESAT-1 and 2, CARTOSAT-1, 2, 2A, 2B, RISAT-1 and 2, OCEANSAT-2, Megha-Tropiques and SARAL.

18.15 Applications of Remote Sensing

1. Agriculture
   (i) Early season estimation of total cropped area
   (ii) Monitoring crop condition using crop growth profile.
   (iii) Identification of crops and their coverage estimation in multi-cropped regions.
   (iv) Crop yield modelling
   (v) Cropping system/crop rotation studies
   (vi) Command area management
   (vii) Detection of moisture stress in crops and quantification of its effect on crop yield
   (viii) Detection of crop violations
   (ix) Zoom cultivation–desertification
2. Forestry
   (i) Improved forest type mapping
   (ii) Monitoring large scale deforestation, forest fire
   (iii) Monitoring urban forestry
   (iv) Forest stock mapping
   (v) Wild life habitat assessment
3. Land use and soils
   (i) Mapping land use/cover (level-III) at 1 : 25000 scale or better
   (ii) Change detection
   (iii) Identification of degraded lands/erosion prone areas
   (iv) Soil categorization
4. Geology
   (i) Lithological and structural mapping
   (ii) Geomorphological mapping
   (iii) Ground water exploration
   (iv) Engineering geological
   (v) Geo-environmental studies
   (vi) Drainage analysis
   (vii) Mineral exploration
   (viii) Coal fire mapping
   (ix) Oil field detection
5. Urban Land use
   (i) Urban land use level IV mapping
   (ii) Updating of urban transport network
   (iii) Monitoring urban sprawl
   (iv) Identification of unauthorised structures
6. Water resources
   (i) Monitoring surface water bodies frequently and estimation of their spatial extent
   (ii) Snow-cloud discrimination leading to better delineation of snow area
   (iii) Glacier inventory
7. Coastal Environment
   (i) More detailed inventory of coastal land use on 1 : 25000 scale
   (ii) Discrimination of coastal vegetation types
   (iii) Monitoring sediment dynamics
   (iv) Siting of coastal structures
8. Ocean resources
   (i) Wealth of oceans/explorations/productivity
   (ii) Potential fishing zone
   (iii) Coral reef mapping
   (iv) Low tide/high tide marking
9. Watershed
   (i) Delineation of watershed boundaries/partitioning of micro watershed
   (ii) Watershed characterization at large scale (size, shape, drainage, land use/cover)
   (iii) Siting of water harvesting structures
   (iv) Monitoring watershed development
   (v) Major river valley projects
10. Environment
    (i) Impact assessment on vegetation, water bodies
    (ii) Siting applications
    (iii) Loss of biological diversity/biosphere reserves/ecological hot spot areas/wet land environment
11. Street network-based application
    (i) Vehicle routing and scheduling
    (ii) Location analysis–site selection–evacuation plans
12. Land parcel-based application
    (i) Zoning, subdivision plan review
    (ii) Land acquisition
    (iii) Environmental management
    (iii) Water quality management
    (iv) Maintenance of ownership
13. Natural resources based applications
    (i) Management of wind and scenic rivers, recreation resources, flood plains, wet lands, agricultural lands, aquifers, forest, wild life etc.
    (ii) Environmental Impact Analysis (EIA)
    (iii) View shed analysis
    (iv) Hazardous or toxic facility siting
    (v) Ground water modelling and contamination tracking
    (vi) Wind life analysis, migration routes planning

14. Facilities management
   (i) Locating underground pipes, cables
   (ii) Balancing loads in electrical networks
   (iii) Planning facility maintenance
   (iv) Tracking energy use
15. Disasters
   (i) Mapping flood inundated area, damage assessment
   (ii) Disaster warning mitigation
16. Digital elevation models
   (i) Contours (> 10 m)
   (ii) Slope/Aspect analysis
   (iii) Large scale thematic mapping upto 1 : 25000 scale

Objective Brain Teasers

Q.1 The infrared portion of EMR lies between
(a) 0.4 - 0.7 ìm (b) 0.5 mm to lm
(c) 0.7 - 1.3 ìm (d) 0.7 to 14 ìm

Q.2 The arrangement of terrain features which provides attributes: the shape, size and texture of objects, is called :
(a) spectral variation (b) spatial variation
(c) temporal variation (d) None of these .

Q.3 Which one of the following frequency regions is a part of sun's radiation?
(a) Ultraviolet frequency region
(b) Radio frequency region
(c) Infrared frequency region
(d) All of these

Q.4 The instruments which provide electromagnetic radiation of specified wave length or a band of wave lengths to illuminate the earth surface, are called :
(a) Sensonrs (b) passive sensors
(c) active sensors (d) None of these

Q.5 Pick up the correct statement from the following:
(a) The distance between two successive crests or troughs of a wave, is called, the wave length
(b) The wave length is measured in metres and a fraction of a metre
(c) The length of the crest from the mid point, is called amplitude
(d) All of these

Q.6 The spectral region of the electromagnetic radiation which passes through the atmosphere without much attenuation is known as:
(a) ozone hole
(b) atmospheric window
(c) ozone window
(d) black hole

Q.7 Remote sensing techniques makes use of the properties of——emitted, reflected or diffracted by the sensed objects:
(a) electric waves
(b) Soundwaves
(c) electromagnetic waves
(d) wind waves

Q.8 The entire range of the electromagnetic spectrum spans a large spectrum of wave lengths varying from:
(a) 10^{-10} to 10^{6} m (b) 10^{-8} to 10^{6} m
(c) 10^{-10} to 10^{10} m (d) 10^{-8} to 10^{8} m

Q.9 Earth observations from a satellite platform provides :
(a) synoptic view of a large area
(b) constant solar zenith angles and similar illumination conditions.
(c) repetitive observations of the same area with intervals of a few minutes to a few weeks
(d) All of these

Q.10 The GPS space segment consists of Navigation Satellite Timing and Ranging whose number is :
(a) 8 (b) 12
(c) 16 (d) 24

Q.11 The various stages occuring in GPS system are described below :
1. Generation of an output to the user
2. Detection of the GPS signal
3. Processing the data in the built-in-computer
4. Decoding the GPS signal.

The correct sequence of the stages is :
(a) 1, 2, 3, 4 (b) 2, 3, 4, 1
(c) 2, 4, 3, 1 (d) 3, 1, 2 , 4

Q.12 The normal altitude of GPS satellite is about
(a) 16, 200 km (b) 20, 200 km
(c) 24, 400 km (d) 36, 100 km

Q.13 GPS has been widely recognized as accurate, fast and cost-effective method for the following:
(a) Collection of the geographic coordinate data used in GIS
(b) for movement of navigation
(c) For determination of precise orbit and altitude of low earth orbiting satellites
(d) All of these

Q.14 Orbital radius of GPS satellites is approximately:
(a) 15,200 km (b) 26,600 km
(c) 18,400 km (d) 36,000 km

Q.15 In GPS, receivers are used are ;
(a) electronic clocks
(b) atomic clocks
(c) quartz clocks
(d) mechanical clocks

Q.16 Which one of the following statements is correct?
(a) The function of an information system is to improve ones ability to make decisions
(b) The information system is the chain of operations
(c) A map is a collection of stored, analysed data, its stored information is suitability used in making decisions
(d) All the above

Q.17 Which one of the following statements is not correct?
(a) GIS technology is the same as traditional mapping
(b) GIS technology is a tool box for processing maps and fundamental concepts for spatial measurement
(c) GIS technology contains analytic capabilities for overlaying maps
(d) GIS technology is capable to study the environmental surrondings

Q.18 The information system is the chain of the following operations,
1. Collection of data
2. Planning the observations
3. Analysis of data
4. Decision making process

Which one of the chains is correct ?
(a) 4, 1, 2, 3 (b) 2, 1, 3, 4
(c) 3, 2, 1, 4 (d) 1, 3, 4, 2

Answers

1. (d)	2. (b)	3. (d)	4. (c)	5. (d)
6. (b)	7. (c)	8. (a)	9. (d)	10. (d)
11. (c)	12. (b)	13. (d)	14. (b)	15. (c)
16. (d)	17. (a)	18. (b)		