1. (a) Explain different types of aerial photographs
(b) Explain with a neat sketch the components of a remote sensing system.

Answer:
(a):
Aerial photography is broken down into two main types, oblique and vertical configuration. Oblique refers to pictures taken the side of an aircraft and vertical images are taken from directly above the subject being photographed. Vertical aerial photography is normally used in real estate advertising. The process of taking photographs in the air from an aircraft is called aviation photography, as is taking pictures of aircrafts themselves. The main types of aviation photography are:

Air-to-air Photography
This type of photograph is used most often in advertising and entails taking pictures of an airplane from different angles. Of course the photographer is in another aircraft, since there has to be at least two aircrafts involved in air-to-air photography. This type of photography is practiced mainly at air shows.

Remote sensing
Remote sensing is used to gather information on the environment and other land base features from a distance, particularly from an aircraft in the sky using special equipment to gather and collect data. This explanation is one of many, but is best suited to aerial photographs.

Satellite
One major use of satellite photos is to gather environmental images so that scientists and environmentalists can track changes on the earth's surface. NASA and the U.S. Department of the Interior are two of the major agencies involved in satellite scanning in the United States.

Kite
The camera is mounted into a cradle and secured to a kite and sent flying; the pictures are taken by controlling the camera with a remote control. In some cases the camera is programmed to automatically snap pictures once the kite reaches a certain altitude.

Also included in aviation photography is the use of model planes and helicopters to take pictures. These are just some of the main types of aerial photographs

(b): Components of Remote Sensing:

1. Energy Source or Illumination: the first requirement for remote sensing is to have an energy source which provides electromagnetic energy to the target of interest.

2. Radiation and the Atmosphere: as the energy travels from its source to the target, it will come in contact with and interact with the atmosphere it passes through. This interaction may take place a second time as the energy travels from the target to the sensor.

3. Interaction with the Target: as the energy travels from its source to the target through the atmosphere, it interacts with the target depending on the properties of both the target and the radiation.

4. Recording of Energy by the Sensor: after the energy has been emitted from the target, we require a sensor (remote -not in contact with the target) to collect and record the electromagnetic radiation. In order for a sensor to collect and record energy reflected or emitted from a target or surface, it must reside on a stable platform removed from the target or surface being observed. Platforms for remote sensors may be situated on the ground, on an aircraft or balloon (or some other platform within the Earth's atmosphere), or on a spacecraft or satellite outside of the Earth's atmosphere. Sensors may be placed on a ladder, scaffolding, tall building, cherry picker, crane, etc. Aerial platforms are primarily stable wing aircraft, although helicopters are occasionally used. Aircraft are often used to collect very detailed images and facilitate the collection of data over virtually any portion of the Earth's surface at any time.

5. Transmission, Reception, and Processing: the energy recorded by the sensor has to be transmitted, often in electronic form, to a receiving and processing station where the data are processed into an image (hardcopy and/or digital).

6. Interpretation and Analysis: the processed image is interpreted, visually and/or digitally or electronically, to extract information about the target, which was illuminated.

7. Application: the final element of the remote sensing process is achieved when we apply the information we have been able to extract from the imagery about the target in order to better understand it, reveal some new information, or assist in solving a particular problem.

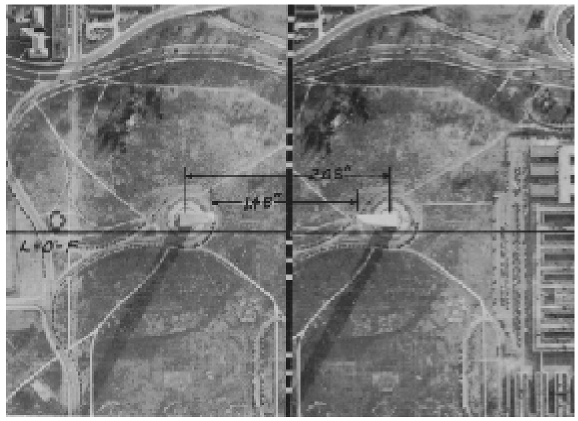
These seven elements comprise the remote sensing process from beginning to end.

2. (a) Write a brief note on stereoscopic parallax
(b) What are the major advantages of digital images over traditional hard copy images?

Answer:
(a) The displacement of an object caused by a change in the point of observation is called parallax.

Stereoscopic parallax caused by taking photographs of the same object but from different points of observation.

Adjacent but overlapping aerial photos are called stereopairs and can be used to measure object height



Note the displacement between the top and base of monument in this steriopair.

Calculating object heights using Stereoscopic parallax:
Absolute parallax-the average photo base length= average distance between PP and CPP

Differential parallax-the difference between the stereoscopic parallax at top and base of the object.

W.M. example: dp = 2.06-1.46=0.6 in

(b) Digital photography is a form of photography that uses an array of light sensitive sensors to capture the image focused by the lens, as opposed to an exposure on light sensitive film. The captured image is then stored as a digital file ready for digital processing (colour correction, sizing, cropping, etc.), viewing or printing.

Until the advent of such technology, photographs were made by exposing light sensitive photographic film and used chemical photographic processing to develop and stabilize the image. By contrast, digital photographs can be displayed, printed, stored, manipulated, transmitted, and archived using digital and computer techniques, without chemical processing.

Digital photography is one of several forms of digital imaging. Digital images are also created by non-photographic equipment such as computer tomography scanners and radio telescopes. Digital images can also be made by scanning conventional photographic images

Hard copy documents are extremely difficult to maintain. The actual physical task for maintaining paper documents is very labour-intensive as well as requiring a great need for storage space when filed. Additionally, gaining access to stored hard-copy documentation is quite tedious and annoying at best!

3. (a) List out various advantages and disadvantages of remote sensing
(b) Describe the procedure for parallax measurements for height.

Answer:
(a): Advantages of remote sensing:

1. Relatively cheap and rapid method of acquiring up-to-date information over a large geographical area.

Example:
Landsat 5 covers each area of 185x160km at a ground resolution of 30m every 18 days, cost of the original digital data is $5 000 (6 200 ha $-1, each hectare contains approximately 11 observations. Even with the cost of ground truthing this is very economical.

2. It is the only practical way to obtain data from inaccessible regions, e.g. Antarctica, Amazonia.

3. At small scales, regional phenomena which are invisible from the ground are clearly visible.

Examples:
Faults and other geological structures. A classic example of seeing the forest instead of the trees.

4. Cheap and rapid method of constructing base maps in the absence of detailed land surveys.

5. Easy to manipulate with the computer, and combine with other geographic coverages in the GIS.

Disadvantages of remote sensing:

1. They are not direct samples of the phenomenon, so must be calibrated against reality. This calibration is never exact, a classification error of 10% is excellent.

2. They must be corrected geometrically and georeferenced in order to be useful as maps, not only as pictures. This can be easy or complicated.

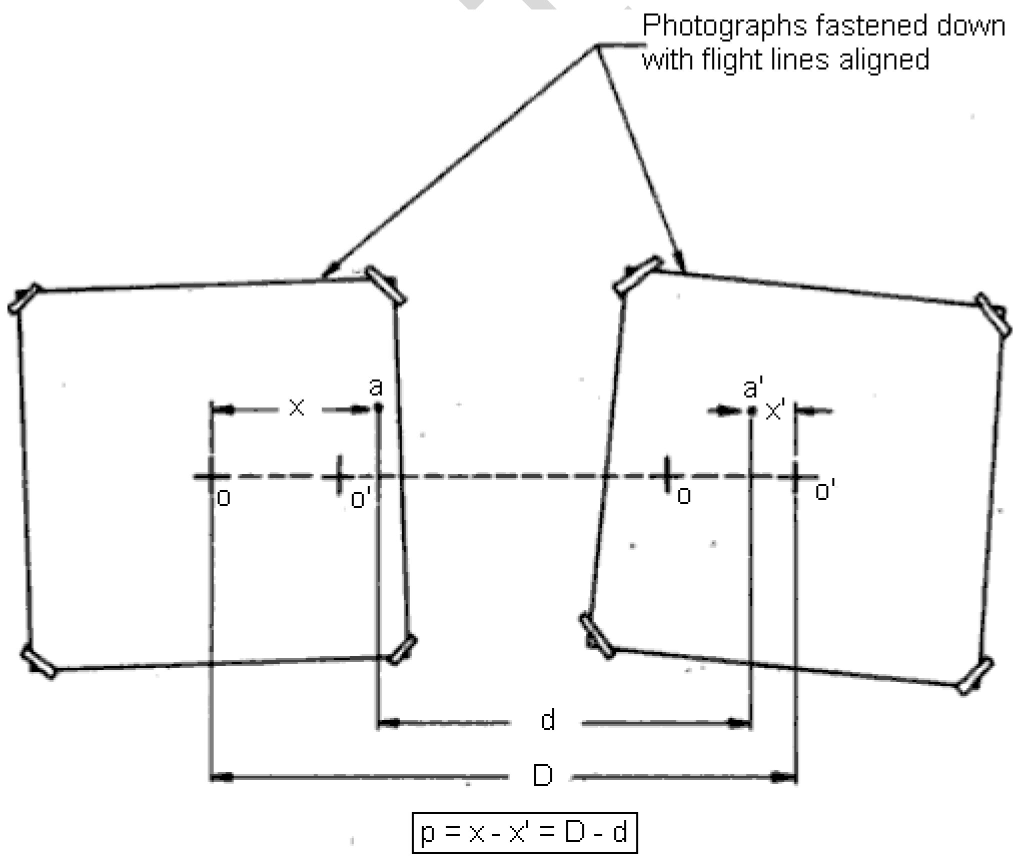
3. Distinct phenomena can be confused if they look the same to the sensor, leading to classification error.

Example: artificial & natural grass in green light (but infrared light can easily distinguish them).

4. Phenomena which were not meant to be measured (for the application at hand) can interfere with the image and must be accounted for.
Examples for land cover classification: atmospheric water vapor, sun vs. shadow (these may be desirable in other applications).

5. Resolution of satellite imagery is too coarse for detailed mapping and for distinguishing small contrasting areas. Rule of thumb: a land use must occupy at least 16 pixels (picture elements, cells) to be reliably identified by automatic methods. However, new satellites are being proposed with 1m resolution, these will have high data volume but will be suitable for land cover mapping at a detailed scale.

(b): Figure illustrates the principle behind methods of parallax measurement that require only a single measurement for each point of interest. If the two photographs constituting a stereopair are fastened to a base with their flight lines aligned, the distance D remains constant for the setup, and the parallax of a point can be derived from measurement of the single distance d. That is, p = D - d. Distance d can be measured with a simple scale, assuming a and a' are identifiable. In areas of uniform photo tone, individual features may not be identifiable, making the measurement of d very difficult.



Alignment of steriopair for parallax measuremnt

Employing the principle illustrated in Figure a number of devices have been developed to increase the speed and accuracy of parallax measurement. These devices also permit parallax to be easily measured in areas of uniform photo tone. All employ stereoscopic viewing and the principle of the floating mark. This principle is illustrated in Figure. While viewing through a stereoscope, the image analyst uses a device that places small identical marks over each photograph. These marks are normally dots or crosses etched on transparent material. The marks - called half marks-are positioned over similar areas on the left-hand photo and the right-hand photo. The left mark is seen only by the left eye of the analyst and the right mark is seen only by the right eye. The relative positions of the half marks can be shifted along the direction of flight until they visually fuse together, forming a single mark that appears to "float" at a specific level in the stereomodel. The apparent elevation of the floating mark varies with the spacing between the half marks. Figure illustrates how the fused marks can be made to float and can actually be set on the terrain at particular points in the stereomodel. Half-mark positions (a, b), (a, c), and (a, d) result in floating-mark positions in the model at B, C, and D.

A very simple device for measuring parallax is the parallax wedge. It consists of a transparent sheet of plastic on which is printed two converging lines or rows of dots (or graduated lines). Next to one of the converging lines is a scale that shows the horizontal distance between the two lines at each point. Consequently, these graduations can be thought of as a series of distanced measurements as shown in Figure.

4. (a) Explain the necessity of ground control points for aerial photography
(b) List various photogrammetric activities and explain any one in detail.

Answer:
(a):
The ground control points appearing in photographs are required to linked to the ground point of known locations. To achieve this they must be few points appearing in photographs whose coordinates w.r.t ground reference co-ordinates systems. Ground control is also required for the orientation of photo in space relative to ground. The number of ground control points depends on navigational control cartographical process of map making. The ground control for aerial photogrammetry is classified as

1. Horizontal
2. Vertical control

(b) No Answer

5. a. Explain the fields of applications of Photogrammetry.
b. Explain the advantages of aerial surveys over conventional ground surveys.
(8 +8)

Answer: In the field of Photogrammetry, Intec Info.com provides services in photogrammetry using Satellite images as well as aerial photographs. Thus enabling the user base to make use of and analyze the data in a heterogeneous environment for**:**

1. Aerial photography interpretation

2. Stereo-pair digital orientation

3. Digital aerial photography geographical mosaic

4. Digital aerial photography rectification and geometric correction

5. Building height measurement by digital stereo aerial photography

6. Spot height extraction by digital stereo aerial photography

7. Contour line generation by digital stereo aerial photography

8. Digital terrain model generation by digital satellite stereo-pair

Satellite photogrammetry, which uses images from earth observation satellites, makes it possible to determine the shape, dimensions and positions of observed phenomena in a given reference system. It applies the same rigor as digital photogrammetry based on aerial photography with accuracy that depends on data resolution.

Satellite photogrammetry has been a major step forward in the mapping as it facilitates to map large areas with very few images taken by satellites and is cost effective compared with aerial photography. Aerial Photogrammetry can be used to scan a particular extent of area and the image specifications like scale, camera, time of photograph etc can be manipulated.

(b): There are many advantages in aerial survey for photographing the earth's surface may prove to be expensive, but it is very rapid. One flight of aeroplane may cover an area of thousands of square kilometers with in a day, while for a party of surveyors it would take several years.

1. Economy of life: In the initial stage, an aerial survey for photographing the earth's surface may prove to be expensive, but it is very rapid. One flight of aeroplane may cover an area of thousands of square kilometers within a day, while for a party of surveyors it would take several years.

In oil exploration, aerial photography was adopted as one of the main problems which prospecting companies had solved was to find a rapid method of constructing accurate geological maps, which were indispensable for geological exploration to facilitate and speed up the lengthy and expensive work of the geologist. For the geological work aerial photographs were found most suited to achieve the aim of quick and accurate geological has enabled the oil prospecting companies to make important saving both in time and money. For instance, photo geological survey in Sahara desert enabled the surveying party to make three quarter saving in terms of time and money.

2. Economy of money: In the initial stage, the expenditure on aerial photography is much more but in the long run the expenditure becomes many times less than the manual field work to cover the same area. The main expenditure includes the cost of an aeroplane, modern cameras and other equipment which are costlier than the films, photographic chemicals for development, printing etc. In the long run of aerial surveying not only the cost of equipment and planes is covered but the multipurpose uses of aerial photographs make it more economical.

3. Greater Accuracy: The maps prepared from photo geological techniques are much more accurate than those from conventional field work, because the possibility of human errors are greater in the latter case. On aerial photographs, the boundaries between the various geological formations, location of field objects or the cultural features are reproduced as a accurately as they actually occur in the area. However, there is a possibility of errors in case of oblique photographs or even the vertical photographs due to relief displacement in the region of high relief. Such errors can easily be rectified by various simple photogrammetric instruments. A better photo-interpretation is based on better known facts about the region that results in greater accuracy. It is important to collect all the existing geological information of the area, both before and during photo-interpretation to help in the preparation of sound and reliable geological maps. Therefore, there must be a close co-operation between the field of geologist and the photogeologist. It is desirable and sometimes necessary for the latter to make short trips to the field for photogeological field check.

6. a. Describe the types of aerial photographs.
b. Write notes on stereoscopic study of aerial photos. (12+4)

Answer:
(a): The two main branches of aerial photography are those known as "oblique aerial photography" and "vertical aerial photography"; the latter is sometimes also referred to as "overhead aerial photography". Above It All Aerial Photography supplies of both of these and further information on our oblique and vertical services can be found on their dedicated pages of this website.

Oblique aerial photographs are taken from some kind of aircraft whether this is a fixed wing aeroplane, helicopter or "lighter than air" craft (balloon). The subject is seen at an angle and therefore the photographs are perceived by the human eye as having depth and definition. As the name suggests, vertical aerial photographs are taken from directly overhead looking down vertically and they therefore produce a mostly flat image almost like a map. Both methods were largely developed for military purposes both also have many civilian uses. Oblique aerial photography is commonly used for construction progress reports, archaeology, advertising and promotion work, in the sale of commercial and residential property and land, in legal disputes or just to produce a stunning aerial photograph for display.

Vertical aerial photographs are most commonly used for mapping projects, for land use or geomatic surveys, farm evaluation, flood risk assessment and scientific studies. A growing number of alternative photographic techniques are referring to themselves as aerial photography when in fact they may more properly be called "elevated photography". These techniques employ the use of various equipment to raise a camera above the ground to an elevated position. The method used to raise the camera varies and examples include the use of telescopic poles or masts, kites or even the use of a portable raised platform on which the photographer can stand. If you are interested in using elevated mast photography, this is a service provided by Above It All Commercial Photography.

(b): Stereoscopic study of aerial photographs:
Although the importance of soil survey has been constantly emphasized as a means for obtaining the necessary and basic information for the study of many kinds of land problems, soil survey organizations seldom have the adequate facilitates and support to carry out their tasks, develop their program to promote the solve the two following problems has contributed strongly to this situation:

1. The comparatively high cost of soil surveys, and

2. The length of time required to prepare them.

Recognising these handicaps which have been hindering soil survey organizations and retarding their growth, alternative methods for producing soil maps have becomes the object of research in some far-sighted institutions.

Increased emphasis has been gradually placed on the study of aerial photographs in an attempt to extract from these photographs all the information they contain and which may be related or made useful for soil mapping. More recently techniques based on the stereoscopic analysis of aerial photographs were developed. These techniques have been subjected lately to tests under vastly different environmental conditions. They were used, for example, in formations of Brazil and in the desert and semi-desert land scapes of the middle east.

7. a. Explain the flight planning and designing in aerial photography.
b. Write short notes on mosaic king. (10+6)

Answer:
(a): Flight planning is the process of producing a flight plan to describe a proposed aircraft flight. It involves two safety-critical aspects: fuel calculation, to ensure that the aircraft can safely reach the destination, and compliance with air traffic control requirements, to minimize the risk of mid-air collision. In addition, flight planners normally wish to minimize flight cost by appropriate choice of route, height, and speed, and by loading the minimum necessary fuel on board.

Flight planning requires accurate weather forecasts so that fuel consumption calculations can account for the fuel consumption effects of head or tail winds and air temperature. Safety regulations require aircraft to carry fuel beyond the minimum needed to fly from origin to destination, allowing for unforeseen circumstances or for diversion to another airport if the planned destination becomes unavailable. Furthermore, under the supervision of air traffic control, aircraft flying in controlled airspace must follow predetermined routes known as airways, even if such routes are not as economical as a more direct flight.

The Missouri Highway and Transportation Department (MHTD) has been using GIS technology for several years in various projects and applications. The GIS staff consists of personnel from the GIS Section of the Planning Division with programming support from the Information Systems Division. ArcInfo and ARCVIEW2 are used extensively for Planning's activities and to a lesser degree in other MHTD divisions. GIS and its possible uses are quickly being realized by other divisions.

One of the primary sources of information for the department's design operations is aerial photography. Aerial photographs are acquired by pilots of the Equipment and Procurement Division and photographers of the Photogrammetry Section of the Design Division. The flight planning necessary to determine the locations of the flight paths for this photography is very repetitive and time extensive.

(b): Mosaic king applies not only to images but also to thematic layers and digital elevation models or any two spatial images requiring alignment. As an example, anyone familiar with U.S. digital ortho quads will know they are in tiles, which can be aligned seamlessly for one larger image. Satellite imagery is small scale (covering a large area) usually greater than 100 sq. km/frame. If a larger area is to be viewed then two or more of these frames must be connected together. Aerial photos on the other hand are large scale (covering a small area) in 23cm X 23cm format usually. Scale may vary for each of these images, particularly for aerial photos where flying height varies. In the case of aerial photos there is usually 60% side overlap and 30% end overlap for each pair of photos. Aerial photos, depending again on scale cover smaller areas - usually less than 10 sq km/frame. It may take 100’s if not thousands of aerial photos to cover the same area as one satellite image.

1. Explain the following
(a) Spatial resolution
(b) Spectral resolution
(c) Radiometric resolution
(d) Temporal resolution

Answer:
(a): Spatial resolution: The measure of how closely lines can be resolved in an image is called spatial resolution, and it depends on properties of the system creating the image, not just the pixel resolution in pixels per inch (ppi). For practical purposes the clarity of the image is decided by its spatial resolution, not the number of pixels in an image. In effect, spatial resolution refers to the number of independent pixel values per unit length.

The spatial resolution of computer monitors is generally 72 to 100 lines per inch, corresponding to pixel resolutions of 72 to 100 ppi. With scanners, optical resolution is sometimes used to distinguish spatial resolution from the number of pixels per inch.

In geographic information systems (GISs), spatial resolution is measured by the ground sample distance (GSD) of an image, the pixel spacing on the Earth's surface.

In astronomy one often measures spatial resolution in data points per arc second subtended at the point of observation, since the physical distance between objects in the image depends on their distance away and this varies widely with the object of interest. On the other hand, in electron microscopy, line or fringe resolution refers to the minimum separation detectable between adjacent parallel lines (e.g. between planes of atoms), while point resolution instead refers to the minimum separation between adjacent points that can be both detected and interpreted e.g. as adjacent columns of atoms, for instance. The former often helps one detect periodicity in specimens, while the latter (although more difficult to achieve) is key to visualizing how individual atoms interact.

In Stereoscopic 3D images, spatial resolution could be defined as the spatial information recorded or captured by two viewpoints of a stereo camera (left and right camera). The effects of spatial resolution on overall perceived resolution of an image on a person's mind are yet not fully documented. It could be argued that such "spatial resolution" could add an image that then would not depend solely on pixel count or Dots per inch alone, when classifying and interpreting overall resolution of an given photographic image or video frame.

(b) Spectral resolution:
The spectral resolution or resolving power of a spectrograph, or, more generally, of a frequency spectrum, is a measure of its ability to resolve features in the electromagnetic spectrum. It is usually defined by

where Δλ is the smallest difference in wavelengths that can be distinguished, at a wavelength of λ.

For example, the Space Telescope Imaging Spectrograph (STIS) can distinguish features 0.17 nm apart at a wavelength of 1000 nm, giving it a resolving power of about 5,900. An example of a high resolution spectrograph is the Cryogenic High-Resolution IR Echelle Spectrograph (CRIRES) installed at ESO's Very Large Telescope, which has a spectral resolution of up to 100,000.

The spectral resolution can also be expressed in terms of physical quantities, such as velocity; then it describes the difference between velocities Δv that can be distinguished through the Doppler effect. Then, the definition is

where c is the speed of light. The STIS example above then has a spectral resolution of 51 km/s.

(c) Radiometric resolution:
While the arrangement of pixels describes the spatial structure of an image, the radiometric characteristics describe the actual information content in an image. Every time an image is acquired on film or by a sensor, its sensitivity to the magnitude of the electromagnetic energy determines the radiometric resolution. The radiometric resolution of an imaging system describes its ability to discriminate very slight differences in energy. The finer the radiometric resolution of a sensor, the more sensitive it is to detecting small differences in reflected or emitted energy.

(d) Temporal resolution: In addition to spatial, spectral, and radiometric resolution, the concept of temporal resolution is also important to consider in a remote sensing system. We alluded to this idea in section 2.2 when we discussed the concept of revisit period, which refers to the length of time it takes for a satellite to complete one entire orbit cycle. The revisit period of a satellite sensor is usually several days. Therefore the absolute temporal resolution of a remote sensing system to image the exact same area at the same viewing angle a second time is equal to this period. However, because of some degree of overlap in the imaging swaths of adjacent orbits for most satellites and the increase in this overlap with increasing latitude, some areas of the Earth tend to be re-imaged more frequently. Also, some satellite systems are able to point their sensors to image the same area between different satellite passes separated by periods from one to five days. Thus, the actual temporal resolution of a sensor depends on a variety of factors, including the satellite/sensor capabilities, the swath overlap, and latitude.

2. (a) Explain the concept of remote sensing and also explain various elements involved in remote sensing along with a neat sketch.
(b) Briefly explain application of aerial photo interpretation to terrain evaluation

Answer:
(a): Concept Of Remote Sensing: Remote sensing is the science and art of obtaining information about an object area or phenomenon through an analysis of the data

acquired by a device which is not in contact with the object, area or phenomenon under investigation. In the present context, the definition of remote sensing is restricted to mean the process of acquiring information about any object without physically contacting in any way regard less of weather the observer is immediately adjacent to the object or millions of miles away. It is further required that such sensing may be achieved in the absence of any matter in the intervening space between the object and the observer. Consequently, the information about the object, are or any phenomenon must be available in a form that can be impressed on a carrier vacuum. The information carrier, or communication link, is electromagnetic energy. Remote sensing data basically consists of wavelength intensity information acquired by collecting the electromagnetic radiation leaving the object at specific wavelength and measuring its intensity.

(b):
Fields Of Application:
The interpretation aspects of aerial photos have a wide ranging utility value in several fields. In engineering they arc used to obtain a very quick, economical and reliable assessment of ground conditions. This will facilitate the location of communication lines, canals and site location of airports, towns, industries, dams and harbours. It is also put to effective use in the study of water resources including ascertaining of ground water potential and flood control. In the field of geology aerial photo techniques arc used for mineral exploration and mining. Its use in the agricultural surveys is of very great importance because of the necessity of putting the land to its best use in view of the increasing need for food and fibres. They also help in the appraisal of soil resources, landuse and land capability. In the field of forestry aerial photographs arc used to take an inventory of forests in terms of species of trees and vegetational mapping. These techniques provide us with a simple and economical method of preparing detailed maps for urban and regional planning and development. It also facilitates the determining of the best means of developing new areas, services, facilities and policies to the ultimate benefit of humanity.

3. Explain the following earth resources satellite
(a) LANDSAT
(b) NOAA

Answer:
(a) LANDSAT
Landsat was not a large project by the standards of the program to put human beings in space, but it involved broader concerns for NASA and a large-project management style. Landsat gained public attention, and a Collier Trophy, because it symbolized a wish that the space program would bring more obvious benefits on earth. NASA leaders sought to respond to such concerns from Congress and the general public by playing up the idea that Earth resources satellites could serve the public good, while at the same time promising quick commercialization. But this commitment lacked stamina; NASA leaders still saw space exploration as the core mission of the agency, and the agency tended to further define that mission as research and development only, not operational

data collection or promoting use of the resulting data. Landsat became a project intended to provide political or bureaucratic capital to NASA and its supporters, and those motivations further complicated the problem of balancing the needs of researchers and of potential operational users.

The project found itself repeatedly strangled in the budget process and by conflicts with the user agencies, even after it had (in the eyes of participants) "succeeded magnificently from a scientific and engineering sense. Most of the scientists and engineers involved at the working level committed themselves wholeheartedly to developing the possibilities for a civilian earth-observation satellite to serve the public good. But funding for the project and approval of subsequent steps was repeatedly caught up in conflicts both between NASA, the Office of Management and Budget, and Congress over funding and between NASA and the agencies that would use the data over the future of the project.

(b) NOAA

Several generations of satellites in the NOAA series have been placed in the orbit. The satellites NOAA-6 through NOAA-10 contained Advanced Very High Resolution Radiometer (AVHRR). The even numbered missions have day light north-to-south equatorial crossing and the odd numbered missions have night time north-to-south equatorial crossing. Apart from routine vegetation dynamics, flood monitoring, regional soil moisture analysis , dust and sandstorm monitoring, forest wild fire mapping ,sea surface temperature mapping, and various geological applications, including observation of eruptions and mapping of regional drainage and physiographic features.

Three of the older NOAA weather satellites which have been decommissioned and are tumbling freely are known to sporadically put out a carrier on 137.500 MHz. The satellites are TIROS-N, NOAA 6 and NOAA 9 When the relevant footprints overlap this will cause interference to NOAA 17 when active on this frequency.

4th June 2010 update for NOAA 9.

Mike Piper from Oregon has provided an interim update suggesting that there are signs that the tumbling which had hit a slow point is beginning to speed up again and that interference may be a bit less. He hopes to have a further update soon after more investigation.

NOAA 16's APT transmission system failed a few months after launch.

Metop-A's A-side LRPT transmitter has failed. Currently the redundant B-side transmitter is off until further notice (No further service expected due to interference with HIRS instrument).

NOAA 14 was decommissioned on 23rd May 2007.

NOAA 12 was decommissioned on 10th August 2007.

Signals have been reported from Meteor M N1 but they are sporadic with periods off. Although classed as LRPT it does not conform to the CGMS standard.

NOAA 17 has scan motor problems with rising motor currents.

Constant rephase by the MIRP was causing data dropouts on all the HRPT Stream and APT and GAC derivatives.

Auto re-phase has now been disabled and the resulting AVHRR products are almost all unusable. Daily MIRP rephasing via the Stored Command Table began on 18 May 2010 (10/138) - at the first pass over the South Pole each day.

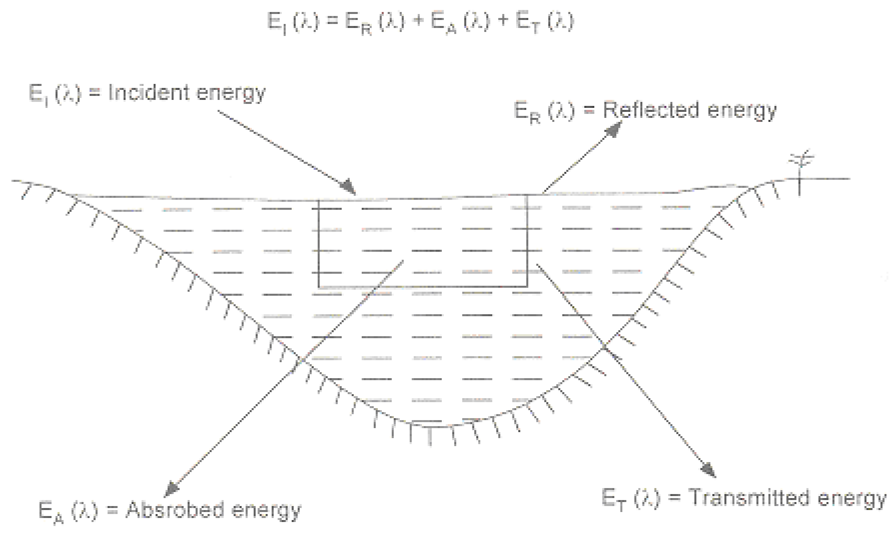
Update 29/09/10 :- Further deterioration in scan motor performance with no useable data from the AVHRR instrument. Scan motor has stalled.

As of 12th October 2010 at 15.00 UTC the following APT frequencies

4. Explain the following
(a) Energy interactions in the atmosphere
(b) Energy interactions with earth surface features.

Answer:
(a) No answer

(b) Electromagnetic energy interactions with earth surface:
When electro magnetic energy is incident on any feature of earth's surface, such as a water body, various fractions of energy get reflected, absorbed, and transmitted as shown in fig. Applying the principle of conversation of energy,



Basic interactions between Electromagnetic Energy and a water body.

$E_I(\lambda) = E_R(\lambda)+E_A(\lambda)+E_T(\lambda)$.

Where, E_I = Incident energy
E_R = Reflected energy
E_A= Absorbed energy
And, E_T = Transmitted energy

All energy components are functions of wavelength, (l). In remote sensing, the amount of reflected energy $E_R(\lambda)$ is more important than the absorbed and transmitted energies. There fore, it is more convenient to rearrange these terms like

$E_R(\lambda) = E_I(\lambda) - [E_A(\lambda)+E_T(\lambda)]$ . . . . (i)

Eq^n (i) is called balance equation. From this mathematical equation, two important points can be drawn. Firstly,

$[E_R(\lambda)/E_I(\lambda)] = [E_I(\lambda)/E_I(\lambda)] - \{[E_A(\lambda)/E_I(\lambda) + [E_T(\lambda)/E_I(\lambda)]\}$ . . . . (ii)

According to principles of physics, it is known that

$(E_R(\lambda)/E_I(\lambda))$; $E_A(\lambda)/E_I(\lambda)$ and $E_T(\lambda)/E_I(\lambda)$ are called reflectance, absorbance and transmittance and can be denoted as $\rho(\lambda)$, $\alpha(\lambda)$, and $\gamma(\lambda)$.

Simply, it can be understood that, the measure of how much electromagnetic radiation is reflected off a surface is called its reflectance. The reflectance range lies between 1 and 1. A measure of 1.0 means that 100% of the incident radiation is reflected off the surface, and a measure '0' means that 0% is reflected. The reflectance characteristics are quantified by "spectral reflectance, $\rho(\lambda)$ which is expressed as the following ratio:

$\rho(\lambda) = E_R(\lambda)/E_I(\lambda)$

$$= \frac{\text{energy of wavelength '}\lambda\text{' reflected from the object}}{\text{energy of wavelength '}\lambda\text{' incident upon the object}} \quad \ldots\ldots\ldots\ldots(iii)$$

Eq^n (ii) can be written as

$$\rho(\lambda) = 1-[\alpha(\lambda)+\gamma(\lambda)] \quad \ldots\ldots\ldots\ldots(iv)$$

Since, almost all earth surface features are very opaque in nature, the transmittance $\gamma(\lambda)$ can be neglected. According to Kirchhoff's law of physics, the absorbance is taken as emissive(ξ). There fore equation (iv) becomes

$$P(\lambda) = 1- \xi(\lambda) \quad \ldots\ldots\ldots\ldots(v)$$

The fundamental equation by which the conceptual design of remote sensing technology is built. If $\xi(\lambda)$ is a zero, then $\rho(\lambda)$, that is, the reflectance is one, which means, the total energy incident on the object is reflected and recorded by sensing systems. The classical example of this of the type of object is snow. If $\xi(\lambda)$ is one, then (λ) is a zero indicating that whatever the energy incident on the object, is completely absorbed by that object.

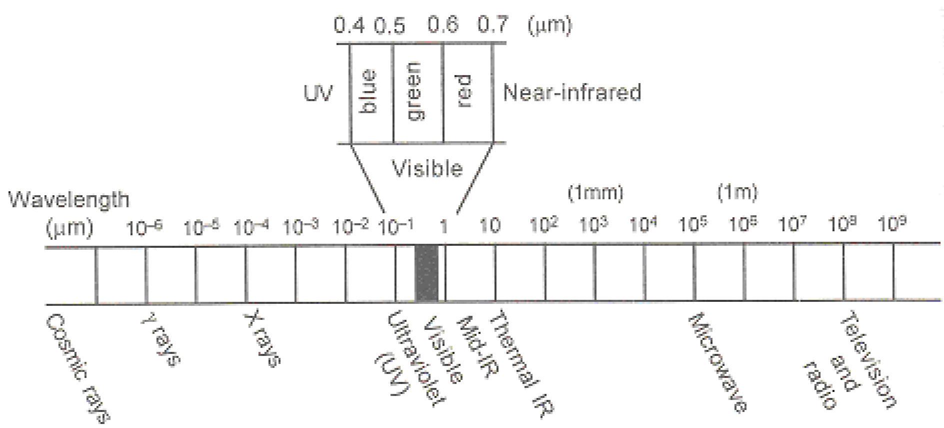
5. a. Describe the electromagnetic spectrum.
b. Write notes on the basic concepts of remote sensing. (8+8)

Answer:
(a): The electro magnetic spectrum may be defined as the ordering of the radiation according to wavelength, frequency, or energy. The wavelength, denoted by λ, is the distance between adjacent intensity maximum (for example) of the electromagnetic wave, and consequently, it may be expressed in any unit of length. Most commonly wavelength and consequently, it may be expressed in any unit of length. Most commonly wave length is expressed in meters (m) or centimeters (cm); microns or micrometers (μ or μ m = 10^{-4} cm); nanometers (nm = 10^{-7}); or Angstrom units (Å= 10^{-8} cm). The frequency denoted by υ, is the number of maxima of the electro magnetic wave that passes a fixed point in a given time. Its relation ship to wavelength is simply,

$$\upsilon = C/\lambda$$

where, C is the speed of light. Frequency is commonly expressed in reciprocal centimeters, also called wave numbers (cm^{-1})or cycles per second (cps) which are also called Hertz (Hz). The wavelengths may assume any value, although for most from the cosmic ray to the audio range. However, wave lengths as long as 10^{11}m have been detected by sensitive magnetometers.

It is all generated by electrically charged matter. However, there is no universal radiation generator that provides a useful intensity of radiation at all wavelengths for practical purposes, and there is no universal wave length resolving instrument or universal detector. Consequently, the spectrum has been divided into regions that bear names related to the sources that produce it, such as, the “ray” regions, or according to the visible range such as, the ultraviolet and the infrared regions, or according to the way in which wavelengths in a range are used such as, radio and television. The extent of the wavelength ranges corresponding to these names were made mostly on the basis of the limits imposed by the human eye(visible), the properties of optical materials, and the response limits of various sources and detectors.



Electromagnetic Spectrum.

(b): Basic concepts of remote sensing:
Remote sensing is the science and art of obtaining information about an object area or phenomenon through an analysis of the data acquired by a device which is not in contact with the object, area or phenomenon under investigation. In the present context, the definition of remote sensing is restricted to mean the process of acquiring information about any object without physically contacting in any way regard less of weather the observer is immediately adjacent to the object or millions of miles away. It is further required that such sensing may be achieved in the absence of any matter in the intervening space between the object and the observer. Consequently, the information about the object, are or any phenomenon must be available in a form that can be impressed on a carrier vacuum. The information carrier, or communication link, is electromagnetic energy. Remote sensing data basically consists of wavelength intensity information acquired by collecting the electromagnetic radiation leaving the object at specific wavelength and measuring its intensity.

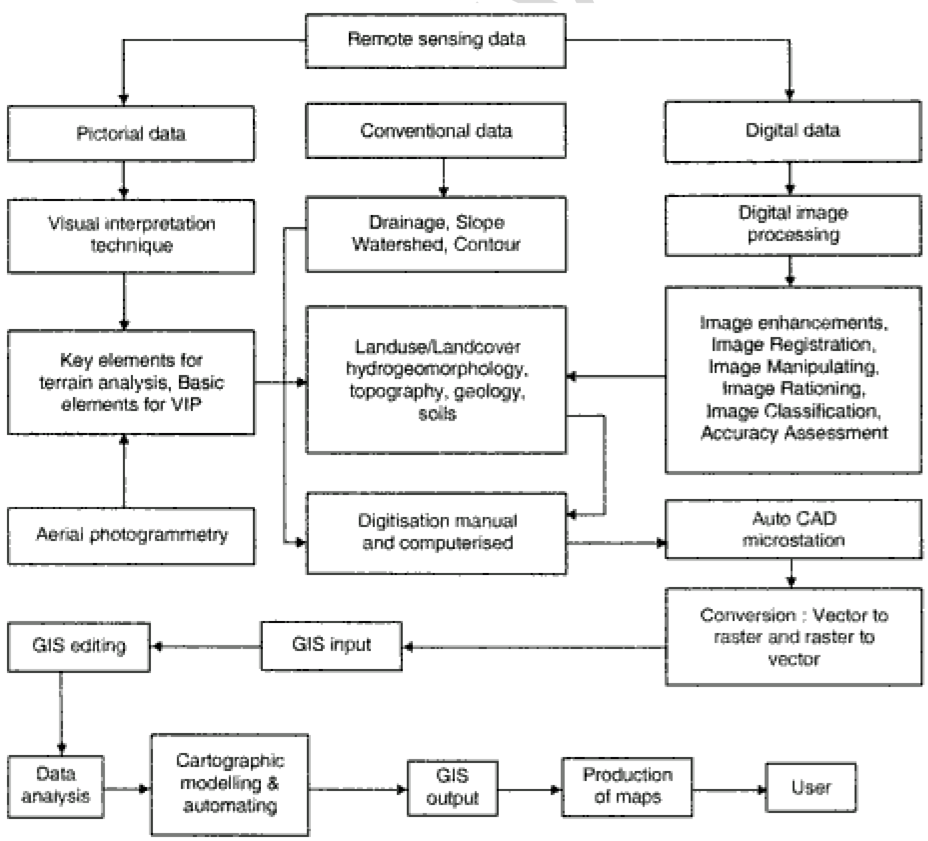
6. a. Explain the electromagnetic remote sensing process.
b. Describe the overview of linkage of remote sensing and GIS. (10+6)

Answer:
(a): The generalised processes involved in electromagnetic remote sensing system or passive remote sensing system, namely, data acquisition and data analysis are outlined below and a schematic diagram of electro-magnetic remote sensing process is shown in

fig. The data acquisition process comprises distinct elements, namely, (i) energy sources, (ii) propagation of energy through the atmosphere, (iii) energy interactions with earth's surface features (iv) airborne sensors to record the reflected energy and (v) generation of sensor data in the form of pictures or digital information. These elements are described in detail further in this chapter.

The data analysis process involves examining the data using various viewing instruments to analysis pictorial data which is called the 'visual image interpretation techniques'. Use of computers to analyse digital data through a process is known as digital image processing techniques. The analysis of a data utilizing visual image interpretation involves use of the fundamental picture elements, namely tone, texture pattern, size and shape in order to detect and identify various objects. Areal or satellite imagery are seen through stereoscopic instruments today for visual interpretation and for transferring the details on to base maps. If the data is available in digital form, it can be analysed on interactive computer systems for extracting statistical data or classified to obtain thematic information about resources. The scene is interactively analysed using computers by comparing with the actual "signature" of the object collected through field visits. This system of classification of objects is quite accurate and depends on the dispersion of training data sets over the area of the scene.

(b): Linkage of remote sensing and GIS:



7. a. State the electromagnetic spectral regions.
b. Write the advantages of remote sensing. (12+4)

Answer:
(a): Electromagnetic spectral regions

Region	Wave length	Remarks
Gamma Ray	<0.03 nm	Incoming radiation is completely absorbed by the upper atmosphere and is not available for remote sensing.
X- ray	0.03 to 3.0 nm	Completely absorbed by atmosphere. Not employed in remote sensing.
Ultraviolet	0.3 to 0.4 µm	Incoming wavelengths less than 0.3 µm are completely absorbed by ozone in the upper atmosphere.
Photographic UV band	0.3 to 0.4 µm	Transmitted through atmosphere. Detectable with film and photo detectors, but atmospheric scattering is severe
Visible	0.4 to 0.7 µm	Imaged with film and photo detectors. Includes reflected energy peak of earth at 0.5 µm
Infrared	0.7 to 1.00 µm	Interaction with matter varies with wavelength. Atmospheric transmission windows are separated.
Reflected IR band	0.7 to 3.0 µm	Reflected solar radiation that contains information about thermal properties of materials. The band from 0.7 to 0.9 µm is detectable with film and is called the photographic IR band.
Thermal IR	3 to 5 µm band	Principal atmospheric windows in the 8 to 14 µm thermal region. Images at these wavelengths are acquired by optical mechanical scanners and special vidicon systems but not by film. Microwave 0.1 to 30 cm longer wavelengths can penetrate clouds, fog, and rain. Images may be acquired in the active or passive mode.
Radar	0.1 to 30 cm	Active form of microwave remote sensing. Radar images are acquired at various wavelength bands.
Radio	> 30 cm	Longest wavelength portion of electromagnetic spectrum. Some classified radars with very long wavelengths operate in this region.

(b):

Advantages of Remote sensing:

1. Relatively cheap and rapid method of acquiring up-to-date information over a large geographical area.

2. It is only practical way to obtain data from inaccessible regions, e.g. Antarctica, Amezonia.

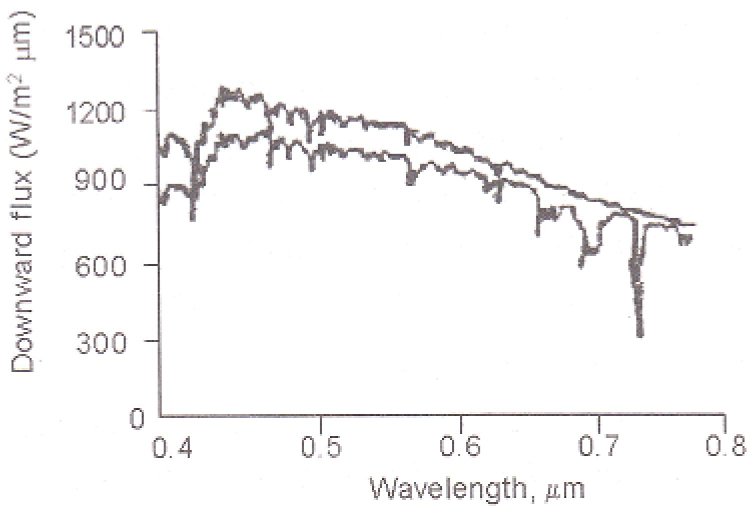
3. At small scales, regional phenomena which are invisible from the ground are clearly visible. A classic example of seeing the forest instead of the trees.

4. cheap and rapid method of constructing base maps in the absence of detailed land surveys.

5. Easy to manipulate with the computer, and combine with other geographic coverages in the GIS.

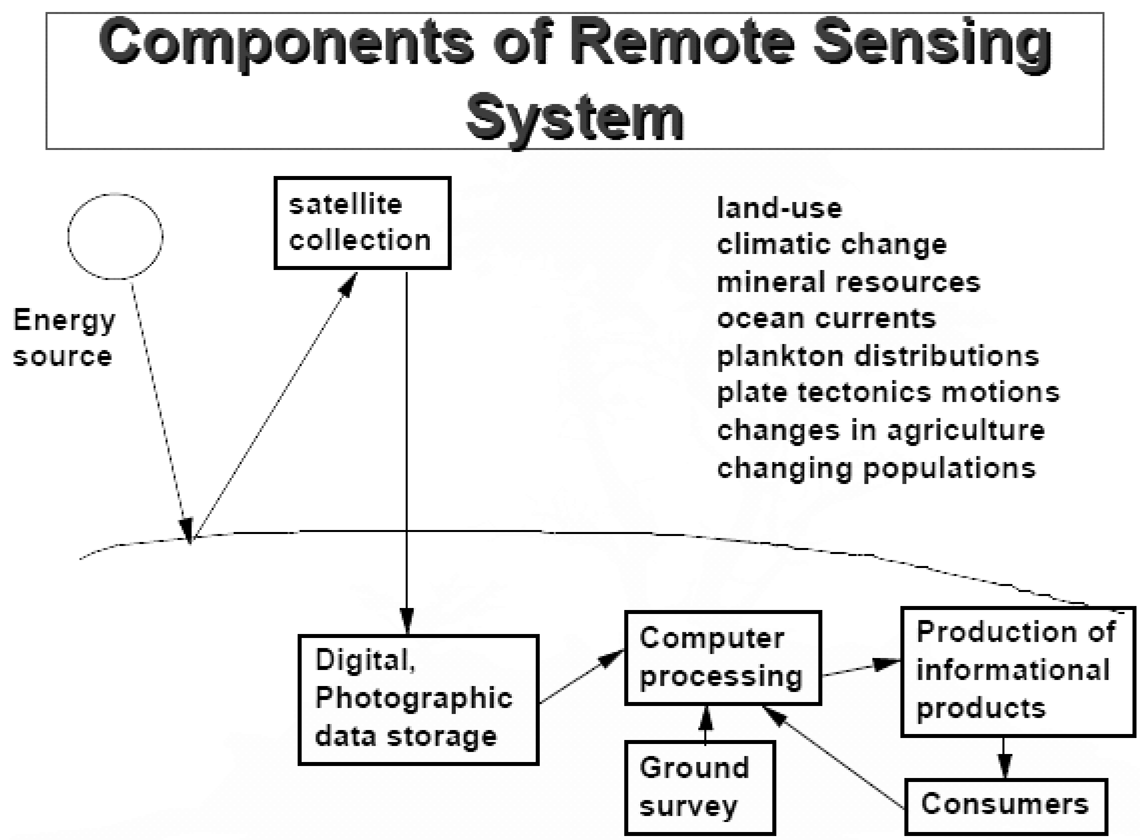
8. a. Explain the significance of atmospheric properties in remote sensing.
b. Write the basic components in remote sensing. (10+6)

Answer:
(a): The main part of the radiance measured from high flying aircraft or satellite stems from multiple scattering in the atmosphere. There fore, the remaining signal can be interpreted in terms of suspensions only after a careful correction for the atmospheric contribution. For this reason the varying optical parameters of atmosphere must enter the radioactive transfer calculations. Before we study the effects of solar radiation and atmospheric properties, we shall consider the mass quantities which determine the spectral upward radiance. The source of the shortwave radiation field in atmosphere is the sun emitting in a board spectral range. The extraterrestrial irradiance at the top of the atmosphere, the solar constant, depends on the black body emission of the sun’s photosphere and on the scattering and absorption process in the Sun’s chromosphere. Important Fraunhofer lines caused by the strong absorption in the sun’s chromosphere show some prominent drops in the spectral distribution of the solar radiation. Fig shows the solar irradiance at the top of the earth’s atmosphere to be between 0.4 to 0.8 μm as determined by Necked and Labs.



Solar irradiance at the top of the atmosphere illuminating the Earth between 0.4 µm – 0.8 µm.

(b):



1. Explain in detail basic elements of image interpretation.

Answer:
Basic elements of image interpretation:

(i) Tone: Ground objects of different color reflect the incident radiation differently depending upon the incident wave length, physical and chemical constituents of the objects. The imagery as recorded in remote sensing is in different shades or tones.

(ii) Texture: Texture is an expression of roughness or smoothness as exhibited by the imagery. It is the rate of change of tonal values. Texture can qualitatively be expressed as course, medium and fine. The texture is a combination of several image characteristics such as tone, shadow size, shape and pattern etc., and is produced by a mixture of features too small to be seen individually because the texture by definition is the frequency of tonal changes.

(iii) Association: The relation of a particular feature to its surroundings is an important key to interpretation. Some times a single featured by itself may not be distinctive enough to permit its identification.

(iv) Shape: Some ground features have typical shapes due to the structure or topography. For example air fields and football stadium easily can be interpreted because of their finite ground shapes and geometry whereas volcanic covers, sand, river terraces, cliffs, gullies can be identified because of their characteristic shape controlled by geology and topography.

(v) Size: The size of an image also helps for its identification whether it is relative or absolute. Sometimes the measurements of height (as by using parallax bar) also gives clues to the nature of the object.

(vi) Shadows: shadows cast by objects are sometimes important clues to their identification and interpretation. For example, shadow of a suspension bridge can easily be discriminated from that of cantilever bridge. Similarly circular shadows are indicative of coniferous trees.

(vii) Size factor or topographic location: Relative elevation or specific location of objects can be helpful to identify certain features. For example, sudden appearance or disappearance of vegetation is a good clue to the underlying soil type or drainage conditions.

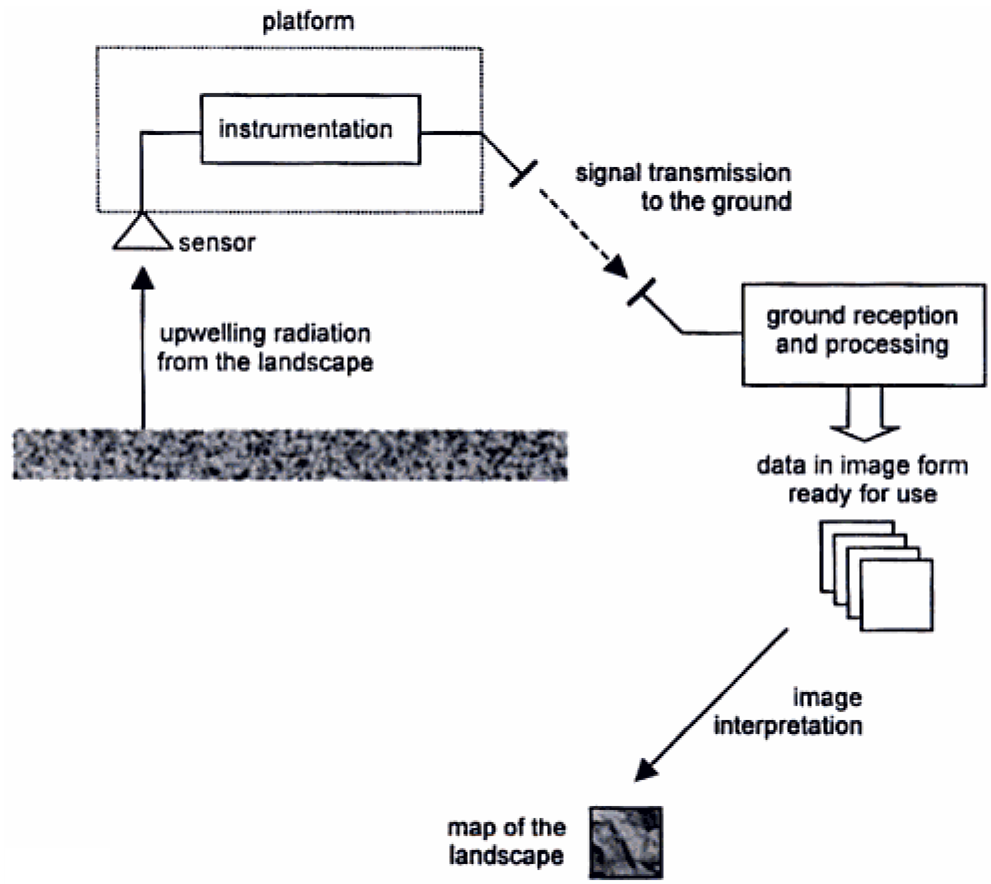
(viii) Pattern: Pattern is the orderly special arrangement of geological topographic or vegetation features. This special arrangement may be two-dimensional or 3-dimensional.

2. (a) Explain the basic character of digital image
(b) What do you mean by image registration

Answer:
(a):
In remote sensing energy emanating from the earth's surface is measured using a sensor mounted on an aircraft or spacecraft platform. That measurement is used to construct an image of the landscape beneath the platform, as depicted in Fig.

The energy can be reflected sunlight so that the image recorded is, in many ways. similar to the view we would have of the earth's surface from an aeroplane, although the wavelengths used in remote sensing are often outside the range of human vision. As an alternative, the upwelling energy can be from the earth itself acting as a radiator because of its own temperature. Finally, the energy detected could be scattered from the earth as the result of some illumination by an artificial energy source such as a laser or radar carried on the platform.

Each of these will be outlined in more detail in the following; it is important here to note that the overall system is a complex one involving the scattering or emission of energy from the earth's surface, followed by transmission through the atmosphere to instruments mounted on the remote sensing platform, transmission or carriage of data back to the earth's surface after which it is then processed into image products ready for application by the user. It is really from this point onwards that the material of this book is concerned, viz. we wish to understand how the data, once available in image format, can be used to build maps of features on the landscape.



(b):

1. Preprocessing: This involves preparing the images for feature selection and correspondence. Using methods such as scale adjustment, noise removal, and segmentation. When pixel sites in the images to he registered are different hut known, one image is resampled to the scale of the other image. This scale adjustment facilitates feature correspondence. II the given images arc known to be noisy, they are smoothed to reduce the noise. Image segmentation is the processor partitioning an image into regions so that features can be extracted.

2. Feature Selection: To register two images, a number of features are selected from the images and correspondence is established between them. Knowing the correspondences, a transformation function is then found to resample the sensed image lo the geometry of the reference image. The features used in image registration arc corners, lines, curves, templates, regions, and patches. The type of features selected in an image depends on the type of image provided. An image of a man-made scene often contains line segments, while a satellite image often contains contours and regions. In a 3-D image, surface patches and regions are often present. Templates ore abundant in both 2-D and 3-D images and can he used as; features to register images.

3. Feature Correspondence: This can be achieved cither by selecting features in the reference linage and searching for them in the sensed image or by selecting features in both images independently and then determining the correspondence between them. The former method is chosen when the features contain considerable information, such as image regions or templates. The latter method is used when individual features, such as points and lines, do not contain sufficient information. If the features are not points, it is important that from each pair of corresponding features at least one pair of corresponding points is determined. The coordinates of corresponding points are used to determine the transformation parameters. For instance, if templates arc used, centers of corresponding templates represent corresponding points; if regions arc used, centers of gravity of corresponding regions represent corresponding points; if lines are used, intersections of corresponding line pairs represent corresponding points; and if curves are used. locally maximum curvature points on corresponding curves represent corresponding points.

4. Determination of a Transformation Function: Knowing the coordinates of a set of corresponding points in the images, a transformation function is determined lo resample the sensed image to the geometry of the reference image. The type of transformation function used should depend on the type of geometric difference between the images. If geometric difference between the inures Is nut known, a transformation that can easily adapt to the geometric difference between the images should he used.

5. Resampling: Knowing the transformation function, the sensed image is resampled to the geometry of the reference image. This enables fusion of information in the images or detection of changes in the scene.

3. Write a note on:
(i) Geometric Correction Methods
(ii) Radiometric correction methods

Answer:
(i) Radiometric Corrections
Since detector output changes gradually over time, it is necessary to calibrate the data they produce. The detectors are calibrated by (a) viewing an electrically illuminated step-wedge filter during each mirror sweep and (b) viewing the sun during each orbit to provide absolute calibration. These calibrated values are used to develop radiometric correction functions for each detector. The correction functions yield digital numbers that correspond linearly with radiance and are applied to all data prior to dissemination. The radiant values contain an added component due to 'air light' reflected from the atmosphere. The removal of this component is described as 'haze removal.' Occasional problems due to transmission cause a 'striping' effect, which is corrected by a normalizing procedure.

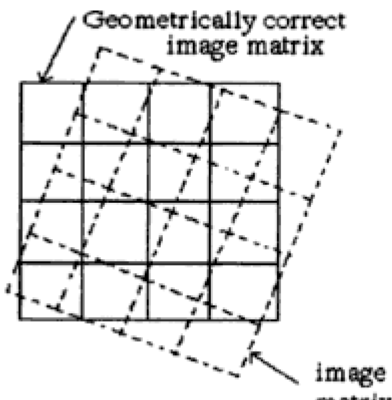
(ii)Geometric Corrections
These corrections are needed due to variations in altitude, attitude, and velocity of the aircraft and eastward rotation of the Earth. The eastward rotation of the Earth causes the mirror sweep to view an area slightly to the west of the previous sweep. Geometric corrections, which are random and complex distortions, are made by analyzing ground

control points and developing the following functions to transform image coordinates (x, y) to ground coordinates (X.Y):

$X = f_1(x, y)$ …………………….(1)

$Y = f_2(x, y)$ ………………………..(2)

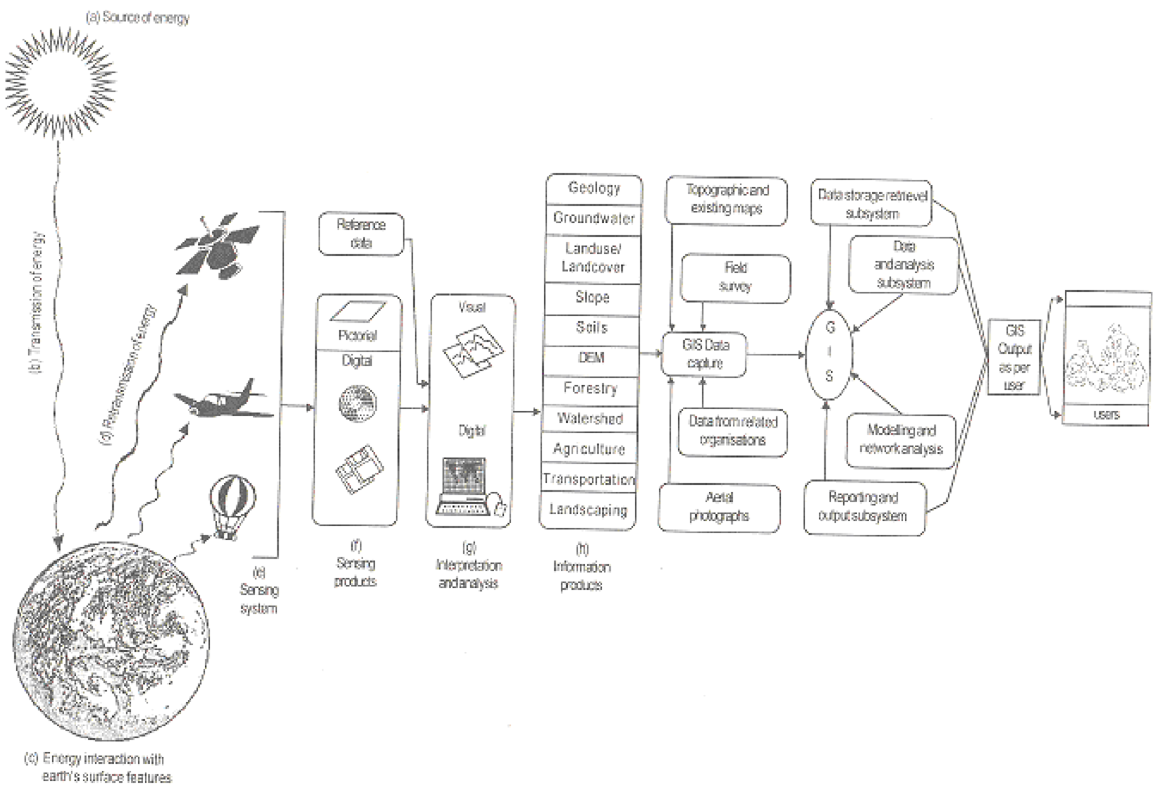
The process by which geometric transformations are applied to the original data is called re sampling. Using f_1 and f_2, the appropriate pixel value (x, y) is transferred from the image dataset to the geometrically correct matrix (Figure).



Geometric correction

4. a. Explain the electromagnetic process in integration with GIS.
b. Explain the electromagnetic energy interactions with earth surface materials. (8+8)

Answer:



(a):

The generalised processes involved in electromagnetic remote sensing system or passive remote sensing system, namely, data acquisition and data analysis are outlined below and a schematic diagram of electro-magnetic remote sensing process is shown in fig. The data acquisition process comprises distinct elements, namely, (i) energy sources, (ii) propagation of energy through the atmosphere, (iii) energy interactions with earth's surface features (iv) airborne sensors to record the reflected energy and (v) generation of sensor data in the form of pictures or digital information. These elements are described in detail further in this chapter.

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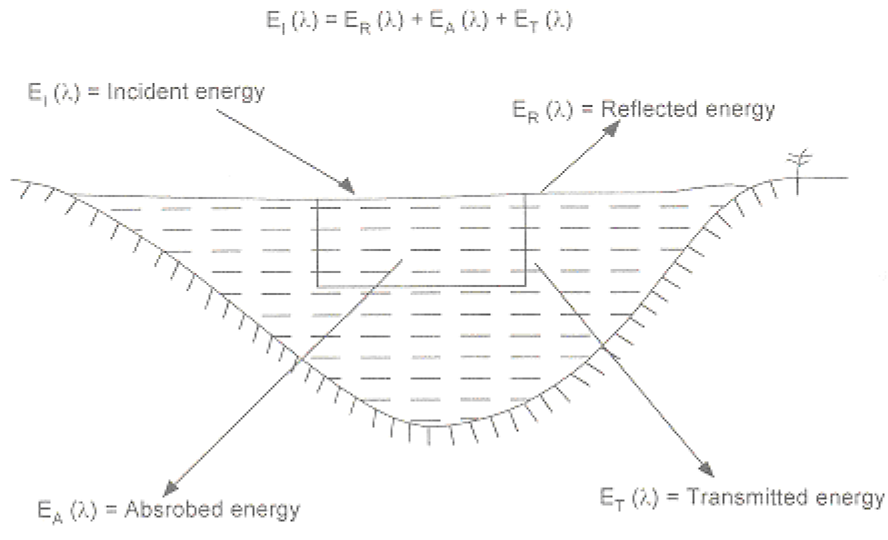
(b): Electromagnetic energy interactions with earth surface materials:

When electro magnetic energy is incident on any feature of earth's surface, such as a water body, various fractions of energy get reflected, absorbed, and transmitted as shown in fig. Applying the principle of conversation of energy,



Basic interactions between Electromagnetic Energy and a water body.

$E_I(\lambda) = E_R(\lambda)+E_A(\lambda)+E_T(\lambda)$.

Where, E_I = Incident energy
E_R = Reflected energy
E_A= Absorbed energy
And, E_T = Transmitted energy

All energy components are functions of wavelength, (l). In remote sensing, the amount of reflected energy $E_R(\lambda)$ is more important than the absorbed and transmitted energies. There fore, it is more convenient to rearrange these terms like

$E_R(\lambda) = E_I(\lambda) – [E_A(\lambda)+E_T(\lambda)]$ . . . . (i)

Eq^n (i) is called balance equation. From this mathematical equation, two important points can be drawn. Firstly,

$[E_R(\lambda)/E_I(\lambda)] = [E_I(\lambda)/ E_I(\lambda)] – \{[E_A(\lambda)/E_I(\lambda) + [E_T(\lambda)/E_I(\lambda)]\}$ . . . . (ii)

According to principles of physics, it is known that

$(E_R(\lambda) /E_I(\lambda))$; $E_A(\lambda)/E_I(\lambda)$ and $E_T(\lambda)/E_I(\lambda)$ are called reflectance, absorbance and transmittance and can be denoted as $\rho(\lambda)$, $\alpha(\lambda)$, and $\gamma(\lambda)$.

Simply, it can be understood that, the measure of how much electromagnetic radiation is reflected off a surface is called its reflectance. The reflectance range lies between 1 and 1. A measure of 1.0 means that 100% of the incident radiation is reflected off the surface, and a measure ‘0’ means that 0% is reflected. The reflectance characteristics are quantified by “spectral reflectance, $\rho(\lambda)$ which is expressed as the following ratio:

$\rho(\lambda) = E_R(\lambda)/E_I(\lambda)$

= (energy of wavelent ‘λ’ reflected from the object)/(energy of wavelength ‘λ’ incident upon the object)…………………(iii)

Eq^n (ii) can be written as

$\rho(\lambda) = 1-[\alpha(\lambda)+\gamma(\lambda)]$ . . . . (iv)

Since, almost all earth surface features are very opaque in nature, the transmittance $\gamma(\lambda)$ can be neglected. According to kirchoff’s law of physics, the absorbance is taken as emissivity(ξ). There fore equation (iv) becomes

$P(\lambda) = 1-\xi(\lambda)$ . . . .(v)

The fundamental equation by which the conceptual design of remote sensing technology is built. If $\xi(\lambda)$ is a zero, then $\rho(\lambda)$, that is, the reflectance is one, which means, the total energy incident on the object is reflected and recorded by sensing systems. The classical example of this of the type of object is snow. If $\xi(\lambda)$ is one, then (λ) is a zero indicating that whatever the energy incident on the object, is completely absorbed by that object.

5. a. Describe the spectral bands of Landsat and Thematic mapper.
b. Write the details of Indian remote sensing satellites (IRS Series) and their sensor capabilities (8+8)

Answer:
(a): Landsats 4 and 5, launched in 1982 and 1984, respectively, were augmented with an advanced version of an Earth observation sensor known as the Thematic Mapper (TM). The TM provides a significant increase in data acquisition capability over the MSS in a number of ways, as shown in the Figure of Observation Characteristics. The TM sensor has seven spectral bands: Six acquire Earth reflectance data, and one acquires Earth temperature data. The spatial resolution of bands in the visible and reflective infrared regions is 30 m, some 2 1/2 times better than the Multi spectral Scanner (MSS). The TM sensor also has greater overall radiometric sensitivity than the MSS.

Currently, the TM sensor on Landsat 5 is still collecting data. EOSAT's construction of a Landsat 6 satellite was intended to continue acquisition of TM data with a so-called "enhanced Thematic Mapper" (ETM). The ETM included the addition of a 15-m panchromatic band to obtain higher spatial resolution. Landsat 6 was lost during launch, however, when it failed to reach orbit in October 1993.

(b): Indian Remote Sensing satellites (IRS) are a series of Earth Observation satellites, built, launched and maintained by Indian Space Research Organisation. The IRS series provides many remote sensing services to India.
Data from Indian Remote Sensing satellites are used for various applications of resources survey and management under the National Natural Resources Management System (NNRMS).

Following is the list of those applications:

1. Preharvest crop area and production estimation of major crops.

2. Drought monitoring and assessment based on vegetation condition.

3. Flood risk zone mapping and flood damage assessment.

4. Hydro-geomorphological maps for locating underground water resources for drilling well.

5. Irrigation command area status monitoring

6. Snow-melt run-off estimates for planning water use in down stream projects

7. Land use and land cover mapping

8. Urban planning

9. Forest survey

10. Wetland mapping

11. Environmental impact analysis

12. Mineral Prospecting

13. Coastal studies

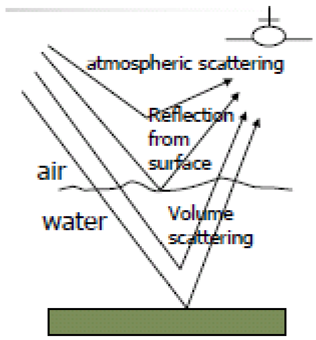
14. Integrated Mission for Sustainable Development (initiated in 1992) for generating locale-specific prescriptions for integrated land and water resources development in 174 districts.

6. a. Describe the spectral characteristics of water bodies.
b. Write notes on spatial and spectral resolution. (10+6)

Answer:

(a): Spectral characteristics of water bodies:

1. radiation incident to the water surface



2. optical properties of water

3. rough ness of the surface

4. Angles of observation & illumination

5. Reflection of light from bottom.

As the sediment concentration increases spectral properties change

i. Overall brightness in visible region increases- no more “dark” object, becomes more of a “bright” object.

ii. Wave length of peak reflectance shifts from the blue to the green region.

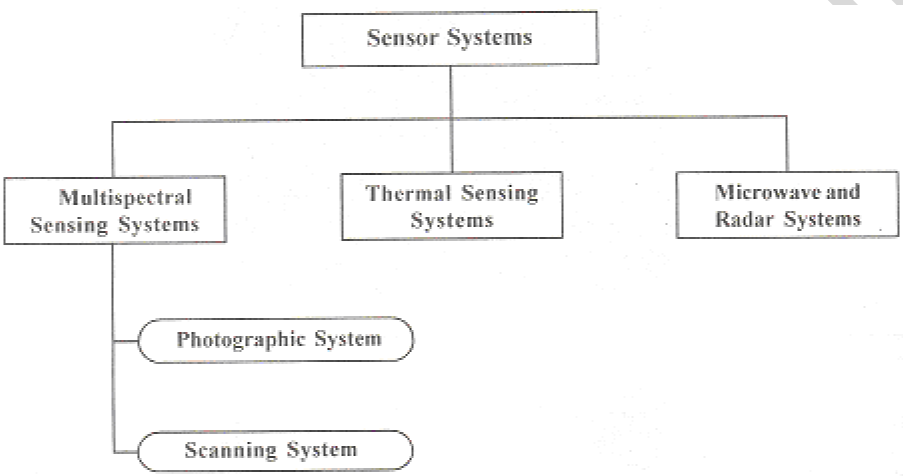
Due to presence of large particles

i. wavelength of maximum scattering shifts towards the blue-green regions.

(b): In various applications of remote sensing, when high spatial resolution is required in addition with classification results, sensor fusion is a solution. From a set of images with different spatial and spectral resolutions, the aim is to synthesize images with the highest spatial resolution available in the set and with an appropriate spectral content. Several sensor fusion methods exist; most of them improve the spatial resolution but with a poor quality of the spectral content of the resulting image. Based on a multi resolution modeling of the information, the ARSIS concept (from its French name "Amelioration de la Resolution Spatial par Injection de Structures") was designed in the aim of improving the spatial resolution together with a high-quality in the spectral content of the synthesized images. The general case of application of this concept is described. A quantitative comparison of all presented methods is achieved for a SPOT image. Another example of the fusion of SPOT XS (20 m) and KVR-1000 (2 m) images is given. Practical information for the implementation of the wavelet transform, the multi resolution analysis, and the ARSIS concept by practitioners is given with particular relevance to SPOT and Landsat imagery.

7. a. Classify and describe the imaging sensor systems.
b. Write the characteristics of Landsat satellites and their sensors. (8+8)

Answer:
(a): Various components of sensor systems operating in the visible, infrared, thermal and microwave regions of the electro magnetic spectrum are described in this section. Although analogue photographic imagery has many advantages, this book is mainly concerned with image data collected by scanning systems that ultimately generate digital image products. It is apparent that the useful wavebands are mostly in the visible and the infrared for passive remote sensing detectors and in the radar and microwave region for active type of sensors. Accordingly the imaging sensor systems in remote sensing are classified as shown in fig.



Classification of imaging sensor systems

Broadly, all the imaging sensor systems are classified based on technical components of the system and the capability of the detection by which the energy reflected by the terrain features is recorded.

The classification scheme is
(a) Multi spectral imaging sensor systems
(b) Thermal remote sensing systems, and
(c) Microwave radar sensing systems.

The multi spectral or multi band imaging systems may use conventional type cameras or a combination of them, along with filters for the various bands in the visible part in the scanning system of multi band imaging. This way electromagnetic energy can be recorded by scanning the ground bit by bit. In some instances, both photographic and scanning systems like Return Beam Vidicon sensor of Landsat which is almost similar to an ordinary TV camera are used.

(b): Characteristics of Land Sat satellites and their sensors:

Satellite Capabilities:		
Particulars	Landsat- 1 to 3	Landsat – 4 & 5
Altitude	919 Km	705 Km
Orbit	Near-Polar Sun-synchronous	Near-Polar Sun-Synchronous
Inclination	99.09 degree	98.2 Degrees
Period	103 minutes	99 minutes
Equatorial crossing time	0930 Hours	0945 Hours
Repeat Cycle	18 Days	18 Days
Swath Width	185 km	185 Km
Data rate	15.06 Mbps	84.9 mbps

Sensor Capabilities:

Sensor	**Mission**	**Channel**	**Spectral Spatial Resolution (Microns)**	**Spatial Resolution**	**Radiometric Resolution**
RBV	Landsat 1 to 3	1 2 3 4	0.475-0575 0.580-0.680 0.690-0.830 0.505-0.750	80 m 80 m 80 m 80 m	6 bits (127 levels)
MSS	Landsat 1 to 5	1 2 3 4 5	0.5-0.6 0.6-0.7 0.7-0.8 0.8-1.1 10.4-12.6	79/82 m* 79/82 m* 79/82 m* 79/82 m* 240 m	6 bits (127 levels)
TM	Landsat 4 & 5	1 2 3 4 5 6 7	0.45-0.52 0.52-0.60 0.63-0.69 0.76-0.90 1.55-1.75 2.08-2.35 10.4-12.5	30 m 30 m 30 m 30 m 30 m 30 m 120 m	8 bits (255 levels)

*The Spatial Resolution is 79 m for Landsat-1, 2 &3. It is 82 m for Landsat 4 & 5.

UNIT-IV

1. List various image enhancement techniques and explain each in detail.

Answer:
Two main concerns for any document imaging exercise are the image quality and the file size. Anyone will need to get the best possible image quality while keeping the file size to a minimum for obvious reasons. Thus image enhancement has become an essential step in a well defined capture workflow. The purpose of image enhancement (image cleanup / image processing) is to make the images more readable, and also to remove unwanted noise reducing the storage requirements. This is especially important for forms processing / OCR applications in order to improve character recognition. There are number of image enhancement techniques available today. Described below are 8 such image processing techniques.

1. Deskewing:
In a production scanning set up, document pre-processing is the most time consuming step. One objective of this step is to arrange the documents correctly by rotating (incorrectly filed documents) and aligning them together. The De-skew facility in production capture applications helps to reduce this effort by automatically de-skewing misaligned images. The De-skew process can straighten pages which were misaligned during the document feeding process, within a specified range of degrees.

A more advanced feature is available with Kofax VRS called content based rotation. VRS can analyze the content of the image and correct the orientation accordingly.

Here is a nice illustration called “The Effects of Deskewing a Document” in ScanHelp.com

2. Black border cropping & removing:
Cropping refers to the removal of the outer parts of an image. In document scanning, black border cropping is one technique that is used to remove the unnecessary black colour borders from an image. Border cropping removes black borders from the image completely also resulting in the reduction of image height and width. However this does not reduce the resolution of the image. (This is an Illustration of border cropping).

The other technique is to replace the black coloured pixels in the borders with white colour pixels which is called black border removal. Unlike cropping this does not reduce the image size.

3. De-speckling / Noise reduction:

When scanning old documents we usually get unwanted dots (speckles) in the background. This could be in two forms; black speckles in a white background as well as white speckles in a black background. This is also known as Salt and pepper noise. (This is an example for an image with salt and pepper noise)

Whatever the form, this affects the image compression and increases the file size. De-speckling (also known as noise reduction) is the process of removing such unwanted speckles from the image background. (Illustration : noise removal)

4. Colour drop out:
Colour dropout is a proven useful technique for forms processing applications such as census projects. The idea is to discard the text boxes and lines of a scanned image. This will increase the recognition rate of OCR. Earlier scanners used specific colored lamps to achieve this. (eg : Blue Imaging Color Drop-Out Element for Kodak 9520/9500). Now this has been improved and is achieved by software.

Colour drop out accuracy directly depends on the printing quality of the forms. Only selected colors (shades of red, blue and green) can be dropped, which depends from scanner to scanner. Therefore it is essential to use the recommended color pantone (e.g. : Fujitsu PANTONE Dropout Confirmation Listing) for printing the forms.

This is a very informative article on color drop-out by the Document Doctor.

5. Thresholding:
Thresholding is a technique used when scanning grayscale images and saving as Black & white. A grayscale image will have 16 bits per pixel (representing 65,536 shades of gray) and a black & white image will have 1 bit per pixel (representing either black or white). When converting from grayscale to black & white (example: scanning a photograph in black & white mode), each pixel having a different shade of gray should be converted in to either black or white. This point of separation is called the threshold. By changing the threshold value the output image quality will change

As shown in the above illustration this is a fixed thresholding, which is ideal for separating solid colors (e.g.: text) from background. However for images with various shades of gray a advanced version of thresholding called adaptive thresholding is used. In adaptive thresholding the threshold value is calculated independently from pixel to pixel based on the contrast. Different scanner manufacturers and capture applications have come up with many different technologies and algorithms on this such as Kodak ithresholding developed on Adaptive Threshold Processing - ATP)

6. Line Removal:
Line removal is a very useful feature especially for OCR applications. This feature is used to remove unwanted lines from scanned images. These lines could be either actual content or noise. Most application forms such as credit cards, account opening etc.. consist of text boxes. Although such lines are actual content of the document, they interfere in the character recognition process hence are unwanted. Also when scanning documents that are folded or when scanning fax copies, there is a high possibility of getting unwanted horizontal lines in the scanned image. These lines, especially vertical ones can interfere in the OCR process. Also if there are any texts that intersect with

these lines, they appear as broken in the scanned image resulting in incorrect text recognition.

When line removal is used, these unwanted lines will not be included in the scanned image resulting in a clean image optimized for character recognition. Also characters that are broken due to horizontal lines will be corrected. Further line removal will also reduce the image size.

7. Punch Hole filling:
When filed documents having punched holes are scanned, most of the images will show these holes as black spots. In addition to the distracted appearance of the image, this results in two main problems. First is If the file contains large number of documents and the left margin is not adequate, these black spots could interfere with the actual content of the document. The second issue is that having such black spots in blank pages could interfere with the automatic blank page deletion, since they could be recognized as actual content. Earlier these black marks were removed manually which required lot of time and effort. With the advancement of image processing applications such as Kofax VRS, this can be now automated. This feature will change the color of such black spots with the surrounding image color. Most such applications take in to consideration the dimensions and locations of such black spots and compare with the different manufacturer specifications and standards.

8. Blank Page Deletion

Blank page deletion is useful when scanning in duplex mode where some documents contain information in both sides of the document as it requires the scanner operator to manually delete the blank pages. Automatic blank page deletion will delete the pages based on a threshold value (in bytes) specified. When a page size is less than the threshold value specified, it is considered as a blank page and will be automatically deleted. Selecting this value depends on the document type and the scanner being used and usually done after some testing with few experimental values. For blank page removal to be effective, it is essential to use some of the features described above such as black border removal, de-speckling, line removal and punch hole filling.

A common issue faced when using blank page deletion is the bleed-through effect, where content in one side of the paper appearing in the other side of the page, especially in very thin papers. Because of this the blank page is mistakenly recognized as having actual content. Advanced capture applications such as Kofax VRS, tries to address this by differentiating actual content and bleed through.

2. a. Write the various definitions of GIS.
b. Write short notes on applications areas for GIS. (8+8)

Answer:
(a): Various definitions of GIS given by various organizations are as follows:

→ A geographic information system, commonly referred to as a GIS, is an integrated set of hardware and software tools used for the manipulation and management of digital special (geographic) and related attribute data.

→ A geographic information system (GIS) is computer-based tool for mapping and analyzing things that exist and events that happen on earth. GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps.

→ GIS is an integrated system of computer hardware, software, and trained personnel linking topographic, demographic, utility, facility, image and other resources data that is geographically referenced.

→ A geographic information system (GIS) is a computer-based information system that enables capture, modelling, manipulation retrieval, analysis and presentation of geographically referenced data.

(b): Application areas for GIS: Major areas of GIS application can be grouped into five categories as follows.

Facilities Management:
Large scale and precise maps and network analysis are used mainly for utility management. AM/FM is frequently used in this area.

Environment and Natural Resources Management:
Medium or small scale maps and overlay techniques in combination with aerial photographs and satellite images are used for management of natural resources and environmental impact analysis.

Street Network:
Large or medium scale maps and spatial analysis are used for vehicle routing, locating house and streets etc.

Planning and Engineering:
Large or medium scale maps and engineering models are used mainly in civil engineering.

Land Information System:
Large scale cadastre maps or land parcel maps and spatial analysis are used for cadastre administration, taxation etc.

The following table summarizes the major areas of GIS applications

Major areas of GIS applications:

Areas	GIS Applications
Facilities Management	locating underground pipes & cables planning

	facility maintenance telecommunication network services energy use tracking & planning
Environment and Natural Resources Management	Suitable study for agricultural cropping management of forests, agricultural lands water resources, wetlands etc. Environmental impact analysis disaster management and mitigation waste facility site location.
Steel Network	Car navigation (route & scheduling) locating houses and streets site selection ambulance services transportation planning
Planning and Engineering	Urban planning Regional planning Route location of high ways
Land information System	Cadastre administration Taxation Zoning of land use Land acquisition

3. a. Write the advantages and benefits of GIS.
b. What are the basic requirements for GIS. (8+8)

Answer:
(a): In theory, all GIS processes can be undertaken manually. Before GIS, analysis procedures would have been manually undertaken using transparent overlays or run through very slow and cumbersome machines with far less power than the machines of today. The essential advantage of modern GIS, however, is that all the functionality for working with multiple sets of geographic information are grouped and automated within one piece of software. In addition it benefits from modern computer efficiency and speed.

Overall, the use of modern GIS offers many advantages over paper maps**:**

1. Can cope with larger amounts of data.

2. Can cover large study areas (the whole world if necessary).

3. Can conveniently select any sub-study area.

4. Can cope with unlimited and frequent edits and changes.

5. More robust and resistant to damage.

6. Faster and more efficient.

7. Requires less person time and money.

(b): Basic requirements of GIS: The architecture of distributed GIS a dramatic departure from the web mapping applications. In interactive web mapping, although client-side applications such as Java applets and Achive X controls offer much interactivity between the user and the graphic user interface, the variations of CGI or different CGI extensions at the server side are simply Band-Aid solutions for distributed GIS. From a technical perspective, the middle ware with CGI and its extensions between the web client and the map server cannot provide a truly distributed GIS. To quality as true distributed GIS, a system has to have the following characteristics:

1. It is composed of distributed components; each component has its own functions. For example, a buffer is a component, a “point in polygon” overlay is another component, and so on.

2. The component is distributed. That is, the components could reside in different computers or GIS nodes but interact directly with each other computers on demand.

3. The components is mobile. Although components reside in different computers, they can be retrieved and downloaded into other computers on demand.

4. The components are open and interoperable. Once the components migrate to other computers, they can be assembled and interoperated with other components that may be downloaded from yet another computer. To be interoperable, the components have to be constructed according to standards.

5. The components are searchable and mechanisms are available to purchase and use the components from service providers. A service catalog is needed to advertise the availability and functions of all components.

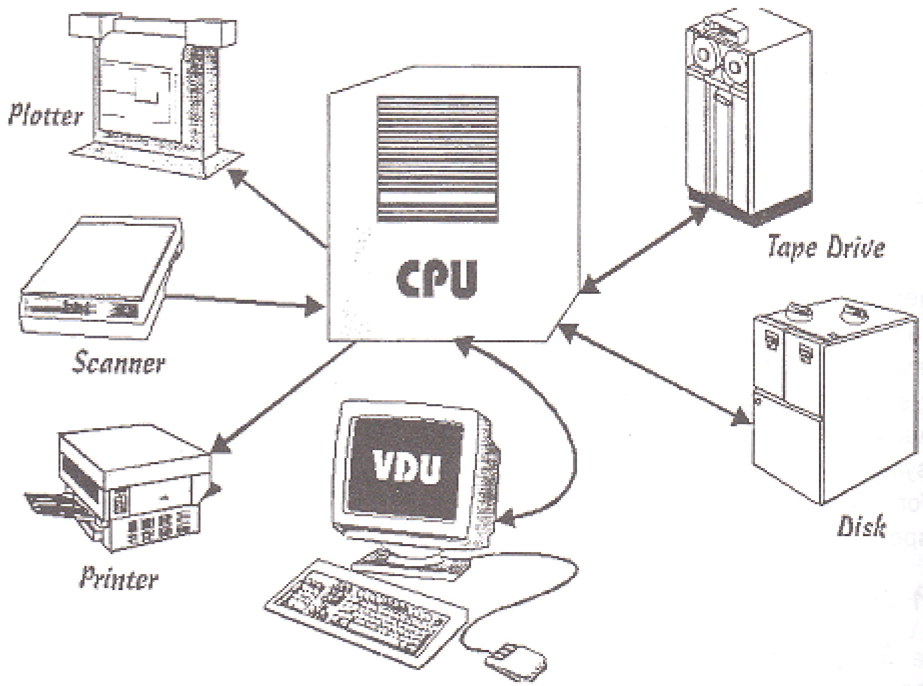
6. Data are distributed. Distributed GIS can access any data repository is provided to connect distributed GIS data on the Internet.

7. Data are interchangeable. This means that data from different sources can be interchanged. Mechanisms are needed to integrate data with different special reference systems, different semantics, and different formats.

4. a. Explain the components of GIS.
b. Write the important terminology of GIS. (8+8)

Answer:

(a): Components of GIS:



Hard ware components of GIS

Geographical Information Systems have three important components, namely, computer hardware, sets of application software modules, and a proper organizational setup. These three components need to be in balance if the system is to function satisfactorily. GIS run on the whole spectrum of computer system ranges from portable personal computers to multi-user super computers, and are programmed in a wide variety of software packages. Systems are available that use dedicated and expensive work stations, with monitors and disitising tables built in. In all cases, there are a number of elements that are essential for effective GIS operations. These include

(i) the presence of a processor with sufficient power to run the software

(ii) sufficient memory for the storage of large volumes of data

(iii) a good quality, high resolution color graphics screen and

(iv) data input and output devices, like digitisers, scanners, keyboards, printers and plotters.

The general hardware components of a GIS include control processing unit which is linked to mass storage units, such as, hard disk drives and tape drives, peripherals such as digitizer or scanner, printer or plotter and Visual Display Unit (VDU). Fig shows the major components of GIS.

(b): Terminology of GIS: GIS are decision support computer based systems for collecting, storing, presenting and analyzing geographical special information. These systems are spatially referenced databases giving users the potentiality to control queries over space, and usually through time. GIS is much more advanced than Computer Aided Design (CAD) or any other special data system. The basic output of GIS or special data analysis system is a map. The need to analyze maps to compare and contrast patterns of earth relates phenomena, is confirmed by the long standing tradition of doing so with traditional maps.

Many geographical phenomena are best described scientifically as fields. Good examples are topographic elevations, air temperatures, and soil moisture content. A 2-D field may be defined as any single valued function of location in a 2-D space and discrete fields, with nominal dependent variables. It appears that any geographical phenomenon can be represented either as a field or as a collection of digital objects. For example, a set of states or revenue or administrative units like mandals with in a country would commonly be represented in a GIS as a set of area objects or a set of linear objects that from their boundaries. Fields can be digitally represented by vector approaches, but are often represented by data structures.

5. a. Write the architecture and work flow of GIS.
b. Write the four M's concept of GIS. (12+4)

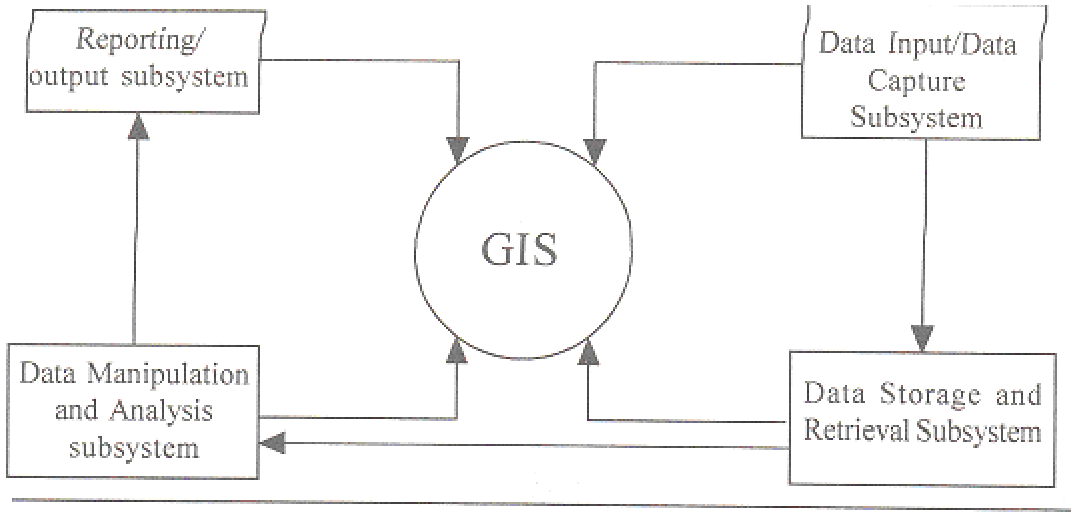
Answer:
(a): GIS Architecture: According to the definition proposed by Marble and Peuquet (1983), GIS deals with space-time data, and often but not necessarily, employs computer hardware and software. GIS can be understood as the subsystem nature within the framework of a main system. According to these investigators, GIS has the following generic subsystems:

(i) A data input subsystem which is also called data capture subsystem

(ii) A data storage and retrieval subsystem

(iii) A data manipulation and analysis subsystem

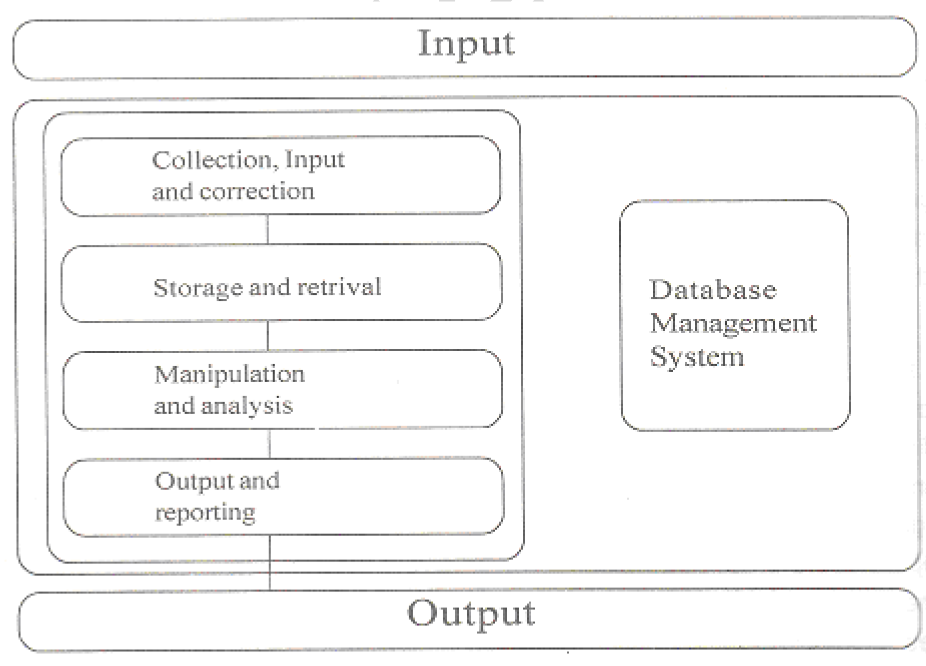
(iv) A reporting subsystem.



Subsystem nature of GIS (structural prespective).

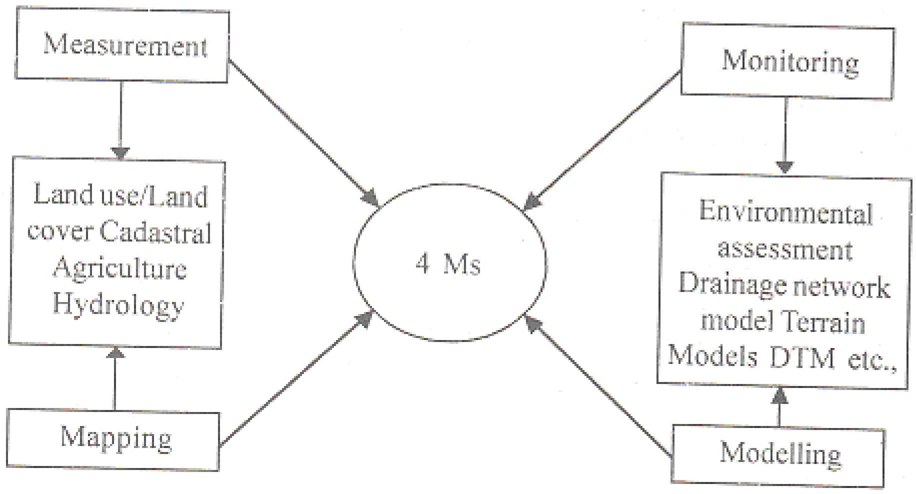
Each of the subsystems has been described in terms of functions that the respective subsystem performs. The data input/capture subsystem provides operational functions for acquiring data. The data management or data storage and retrieval subsystem stores and retrieves the data elements, The manipulation and analysis subsystem handles the transformation of data from one form to another derivation of information from the data. The fourth subsystem output/reporting subsystem provides away for the user to see the data in the form of diagrams, maps, and or tables. Fig shows the architecture of all subsystems of GIS from a structural perspective.

Work flow of GIS:



Workflow process of GIS (Procedural perspective)

(b):



Schernatic representation of Four Ms: Measurment, Mapping, Monitoring and Modelling.

There are mainly four key activities that any urban planners or scientists or resource managers and others use geographic information for. They observe and measure environmental parameters and develop maps which portray characteristic of the earth. They monitor changes in our surroundings in space and time. In addition, they model alternatives of actions and process operation in the environment. These, four activities are Measurement, Mapping, Monitoring and Modeling termed as key activities which can be enhanced by the using information systems technologies through GIS. Fig explains those four Ms.

1. (a) Explain spatial data and non spatial data with suitable example

(b) List out some of the major international GIS vendors.

Answer:

(a): Spatial Data: A spatial characteristic rule is a general description of a set of spatial related data. For example, the description of general weather patterns in geographic regions is a spatial characteristic rule. A spatial discriminant rule is the general description of contrasting or discriminating features of a class of spatial related data from other classes. For example, the comparison of the weather patterns in two geographic regions is a spatial discriminant rule.

Lu, Han and Ooi (1993) first developed a generalization-based method to discover the characteristic and discriminant rules from the spatial data. The method extracts the general knowledge in two different ways: non-spatial data dominated generalisation and spatial data dominant generalization.

Non Spatial Data: The non-spatial data dominated generalization algorithm creates maps consisting of regions that share the same high-level nun-spatial descriptions. It realizes this by merging the neighboring areas with the same generalized non-spatial attributes. In contrast, a spatial data dominant generalization algorithm focuses first on the spatial data. It partitions the regions and merges them based on the hierarchy of spatial data attributes. In the end, it creates maps consisting of areas that share the same spatial descriptions.

Although the generalization-based approach could find some interesting patterns from the spatial databases, the discovery process depends very much on the availability of the hierarchies of the data. Further, the quality and the interesting-ness of the discovered patterns ore also influenced greatly by the fineness and

appropriateness of the given hierarchies of data.

(b): No answer.

2. Explain the following advanced tools of GIS analysis along with suitable examples

(a) Proximity analysis

(b) Spatial operation

(c) Terrain analysis

(d) Network analysis

Answer:

(a) Proximity analysis

Proximity analysis is one way of analyzing locations of features by measuring the distance between them and other features in the area. The distance between point A and point B may be measured as a straight line or by following a networked path, such as a street network. For example, in a site selection scenario where a prospect is interested in building a manufacturing plant in the Daytona Beach area, an important consideration might be distance from the interstates and the airport. A GIS user can simply click on the point locations representing the site and the interstate exit ramp or airport to obtain an approximate distance measure. Once the distances are determined, other pertinent information such as water and sewer availability, price per acre, and availability of labor can be analyzed from the database.

(b) Spatial operation

Spatial operation are based on computational algorithms developed in a research field called computational geometry. Computational geometry is a subfield of computer science, which was first advocated by Ian shamos in1986 in his dissertation. Spatial overlay is a spatial operation that puts a map layer on another layer to produce a new layer. This operation is different from visual overlay. Visual overlay displays two layers simultaneously on one device but it does not create new spatial data. Spatial overlay reconstruct the topology of special objects when they are represented by arc node structure.

(c) Terrain analysis

The heart of GIS is the analytical capabilities of the system. What distinguish the GIS system from other information system are its spatial analysis functions. Although the data input is, in general, the most time consuming part, it is for data analysis that GIS is used. The analysis functions use the spatial and non-spatial attributes in the database to answer questions about the real world. Geographic analysis facilitates the study of real-world processes by developing and applying models. Such models illuminate the underlying trends in geographic data and thus make new information available. Results of geographic analysis can be communicated with the help of maps, or both.

The organization of database into map layers is not simply for reasons of organizational clarity; rather it is to provide rapid access to data elements required for geographic analysis. The objective of geographic analysis is to transform data into useful information to satisfy the requirements or objectives of decision-makers at all levels in terms of detail. An important use of the analysis is the possibility of predicting events in the location or at another point in time.

(d) Network analysis

Arc GIS Network Analyst is an extension to Arc GIS Desktop that helps you conduct network-based spatial analysis. With Arc GIS Network Analyst, you can create applications that build multimodal routes, provide travel directions, look for closest facilities, and create service areas and origin-destination cost matrices.

Arc GIS Network Analyst helps you dynamically model realistic network conditions and solve vehicle routing problems that include turn restrictions, speed limits, height restrictions, and traffic conditions at different times of the day.

Drive-time analysis

Point-to-point routing

Fleet routing

Route directions

Service area definition

Shortest path analysis

Optimum route analysis

Closest facility analysis

Origin-destination analysis

3. a. Explain the data conversion by Digitization.

b. Represent the digitizing errors. (12+4)

Answer:

(a): Data conversion by digitisation:

When beginning a session with a digitising tablet, the user must specify the number of attributes of the map, as well as the map's location on the digitising tablet. Typically, the user will be prompted by the system for information about a map's scale and projection; menus with common choices can help the user to enter this information quickly and accurately. After entering this information and a region of interest. In the process of converting the data compatible to any GIS, the most important function one should consider is mode of digitisation.

In general there are three types of mode of digitisation

(i) point mode

(ii) line mode

(iii) stream mode.

In point mode, individual locations on the map, such as elevation, benchmarks, road intersections, and water wells can be entered by placing the cursor over the relevant locations and pressing a button.

In line mode, straight line segments, such as short segments along political boundaries and straight road sections are entered by moving the cursor to one end of the line, pressing a button on the cursor then moving the cursor to the other end and pressing a button again. The system automatically converts these two entered points to an appropriate vector.

In stream mode, the location of the cursor on the map surface is determined automatically at equal intervals of time, or after a specified displacement of the cursor. Stream mode is particularly useful when digitising curved line segments, such as the boundaries of waterways. However, in stream mode it is often too easy to create very large data files, since data points entered into the system very quickly.

(b): No answer

4. a. Describe the data conversion by scanning.

b. Write the classification of vector data analysis methods. (10+6)

Answer:

(a): Scanning is the most commonly used method of automatic digitising. Scanning is an appropriate method of data encoding when raster data are required, since this is the automatic output format from most scanning software. Thus scanning may be used as a background raster dataset for the over-plotting of vector infrastructure data, such as, pipelines and cables.

A scanner is a piece of hardware for converting an analogue source documents to a digital raster format. There are two types of scanners,

(i) flatbed scanner and

(ii) rotating drum scanners. The cheapest scanners are small flatbed scanners, and high quality and large format scanners are rotating drum scanners in which the sensor moves along the axis of rotation.

A digital image of the map is produced by moving an electronic detector across the map surface. The size of the map area viewed by the detector and scanning should be processed or edited to improve the quality and convert the raster to vector after online digitisation. The accuracy of the scanned output data depends on the quality of the scanner, the quality of the software used to process the scanned data, and the quality of the scanner, the quality of the software used to process the scanned data, and the quality of the source document. A very important feature that a GIS user should observe after scanning the paper map is the occurrence of splines, which is black appearance on the scanned output. This can be removed by using a process called thinning.

5. a. Explain about spatial data and its models

b. Outline the digital image processing techniques. (10+6)

Answer:

(a): Spatial data and its models: Spatial data structures provide the information that the computer requires to reconstruct the data models in digital form. Although some lines act alone and contain specific attribute information that describes their character, other more complex collections of lines called networks add a dimension of attribute characteristics. Thus not only does a road network contain information about the types of road or similar variables, but it will also indicate that travel is possible only in a particular direction.

This information must be extended to each connecting line segment to advise the user that movement can continue along each segment until the attributes change-perhaps until a one-way street becomes a two-way street. For example, one node might indicate the existence of a stop sign, a traffic signal, or a sigh prohibiting U-turns. All these attributes must be connected throughout the network so that the computer knows the inherent real-world relationships that are being modeled within the network. Such explicit information about connectivity and relative special relation ships is called topology.

(b): Digital image processing techniques:

Once a radiograph has been processed, the image is permanent and further adjustments cannot be made. If the image is too dark or too light, the image has to be repeated. However, this is not the case with digital images. All digital systems employ a stable electronic circuit called a bit, or binary digit. A circuit containing a bit can electronically be switched into two states, off or on. Off is represented by a zero and on is represented by a one. If a shade or color is assigned to the zero and the one then only two colors can be used, black or white. Digital devices used in radiographic imaging must be able to represent more than two colors. To image several shades of gray there must be more than one bit, or multibits.

The number of bits corresponds to the number of gray levels dis-played by a particular system and is calculated as follows: L = 2n where L is equal to the number of gray levels and n the number of bits. For example, an 8-bit unit can display 28 or 256 shades of gray in an image. Since a digital image is made up of pixels, each pixel is assigned a numerical value corresponding to a shade of gray, thus the density and contrast of the image is adjusted by varying the numerical values of each pixel. Human vision can differentiate approximately 32 gray levels, which means that the dynamic range of the X-ray detection system and the human eye do not match. As a result, the computer must be manipulated to show the proper density and contrast of the final image. Most manufacturers treat the raw data with a firmware before the image is displayed. This simply means that the software in the system uses certain algorithms or mathematical computations set by the manufacturer to optimize the image. However, once the image is dis-played, it can be further processed by the operator to change parameters as desired.

6. a. Compare the raster and vector data.

b. Describe the raster data structure. (8+8)

Answer:

(a): Comparison of raster and vector GIS models:

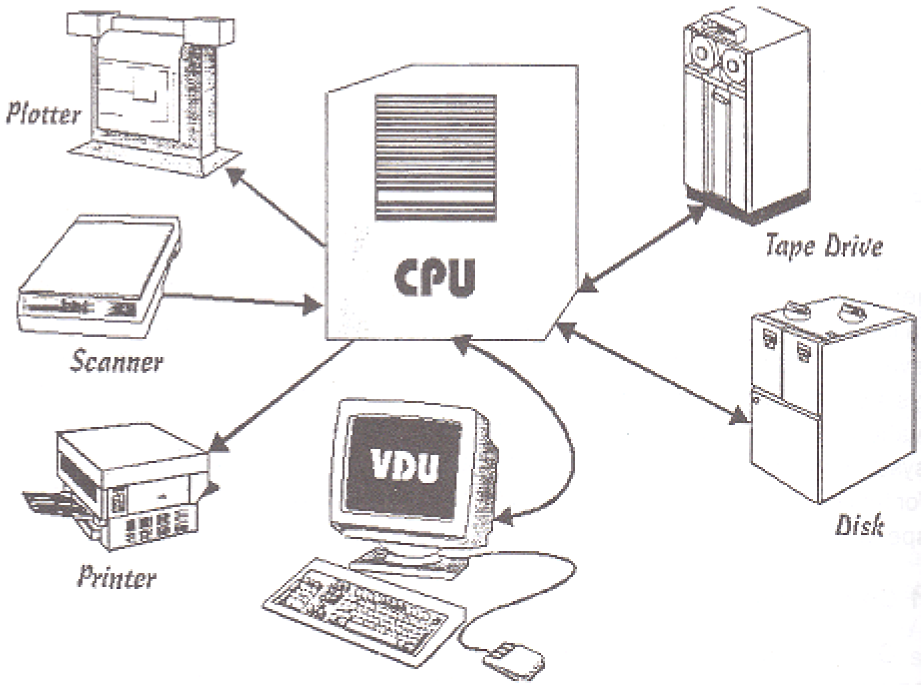
Raster model	**Vector model**
Advantages	**Advantages**
1. It is a simple data structure. 2. Overlay operations are easily and efficiently implemented.	1. It provides a more compact data structure than the raster model.

3. High spatial variability is efficiently represented in a raster format. 4. The raster format is more or less required for efficient manipulation and enhancement of digital images.	2. It provides efficient encoding of topology, and as a result, more efficient implementation of operations that require topological information, such as, network analysis. 3. The vector model is better suited to supporting graphics that closely approximate hand-drawn maps.
Disadvantages	**Disadvantages**
1. The raster data structure is less compact. 2. Topological relation ships are more difficult to represent. 3. The output of graphics is less aesthetically pleasing because boundaries tend to have a blocky appearance rather than the smooth lines of hand-drawn maps. This can be overcome by using a very large number of cells, but it may result in unacceptably large files.	1. It is a more complex data structure than a simple raster. 2. Overlay operations are more difficult to implement. 3. The representation of high special variability is efficient. 4. Manipulation and data enhancement of digital images cannot be effectively done in the vector domain.

(b): Raster data structure: Raster data type consists of rows and columns of cells, with each cell storing a single value. Raster data can be images (raster images) with each pixel (or cell) containing a color value. Additional values recorded for each cell may be a discrete value, such as land use, a continuous value, such as temperature, or a null value if no data is available. While a raster cell stores a single value, it can be extended by using raster bands to represent RGB (red, green, blue) colors, color maps (a mapping between a thematic code and RGB value), or an extended attribute table with one row for each unique cell value. The resolution of the raster data set is its cell width in ground units. Raster data is stored in various formats; from a standard file-based structure of TIF, JPEG, etc. to binary large object (BLOB) data stored directly in a relational database management system (RDBMS) similar to other vector-based feature classes. Database storage, when properly indexed, typically allows for quicker retrieval of the raster data but can require storage of millions of significantly sized records

1. With a neat sketch explain various components of GIS.

Answer:
(a): Components of GIS:



Hard ware components of GIS

Geographical Information Systems have three important components, namely, computer hardware, sets of application software modules, and a proper organizational setup. These three components need to be in balance if the system is to function satisfactorily. GIS run on the whole spectrum of computer system ranges from portable personal computers to multi-user super computers, and are programmed in a wide variety of software packages. Systems are available that use dedicated and expensive work stations, with monitors and disitising tables built in. In all cases, there are a number of elements that are essential for effective GIS operations. These include

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(iii) a good quality, high resolution color graphics screen and

(iv) data input and output devices, like digitisers, scanners, keyboards, printers and plotters.
The general hardware components of a GIS include control processing unit which is linked to mass storage units, such as, hard disk drives and tape drives, peripherals such

as digitizer or scanner, printer or plotter and Visual Display Unit (VDU). Fig shows the major components of GIS.

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Many geographical phenomena are best described scientifically as fields. Good examples are topographic elevations, air temperatures, and soil moisture content. A 2-D field may be defined as any single valued function of location in a 2-D space and discrete fields, with nominal dependent variables. It appears that any geographical phenomenon can be represented either as a field or as a collection of digital objects. For example, a set of states or revenue or administrative units like mandals with in a country would commonly be represented in a GIS as a set of area objects or a set of linear objects that from their boundaries. Fields can be digitally represented by vector approaches, but are often represented by data structures.

2. Discuss various types of Raster GIS models.

Grid:
In this model each grid cell is referenced or addressed individually and is associated with identically positioned grid cells in all other coverages, rather than like a vertical column of grid cells, each dealing with a separate theme. Comparisons between coverages are therefore performed on a single column at a time. Soil attributes in one coverage can be compared with vegetation attributes in a second coverage. Each soil grid cell in one coverage can be compared with a vegetation grid cell in the second coverage. The advantage of this data structure is that it facilitates the multiple coverage analysis for single cells. However, this limits the examination of spatial relationships between entire groups or themes in different coverages.

Imgrid:
To represent a thematic map of land use that contains four categories: recreation, agriculture, industry and residence, each of these features have to be separated out as an individual layer. In the layer that represents agriculture 1 or 0 will represent the presence or absence of crops respectively. The rest of layer will be represented in the same way, with each variable referenced directly. The major advantage of IMGRID is its two-dimensional array of numbers resembling a map-like structure. The binary character of the information in each coverage simplifies long computations and eliminates the need for complex map legends. Since each coverage feature is uniquely identified, there is no limitation of assigning a single attribute value to a single grid cell. On the other side, the main problem related to information storage in an IMGRID

structure is the excessive volume of data stored. Each grid cell will contain more than 1 or 0 values from more than one coverage and a large number of coverages are needed to store different types of information.

MAP model:
This type of data structure integrates the two structure discussed previously. In this raster structure, each thematic coverage is recorded and accessed separately by map name or title. This is accomplished by recording each variable, or mapping unit, of the coverage's theme as a separate number code or label, which can be accessed individually when the coverage is retrieved. The label corresponds to a portion of the legend has its own symbol assigned to it. This structure facilitates the performance of operations on individual grid cells and groups of similar cells, and the resulting changes in value require rewriting only a single number per mapping unit, simplifying the computations. The MAP data structure allows the manipulation of information in a many-to-one relationship of the attribute values and the sets of grids. The MAP is used in GIS mostly.

3. With a neat sketch describe raster and vector data representation.

Answer:
Raster
A raster data type is, in essence, any type of digital image represented by reducible and enlargeable grids. Anyone who is familiar with digital photography will recognize the Raster graphics pixel as the smallest individual grid unit building block of an image, usually not readily identified as an artifact shape until an image is produced on a very large scale. A combination of the pixels making up an image color formation scheme will compose details of an image, as is distinct from the commonly used points, lines, and polygon area location symbols of scalable vector graphics as the basis of the vector model of area attribute rendering. While a digital image is concerned with its output blending together its grid based details as an identifiable representation of reality, in a photograph or art image transferred into a computer, the raster data type will reflect a digitized abstraction of reality dealt with by grid populating tones or objects, quantities, cojoined or open boundaries, and map relief schemas. Aerial photos are one commonly used form of raster data, with one primary purpose in mind: to display a detailed image on a map area, or for the purposes of rendering its identifiable objects by digitization. Additional raster data sets used by a GIS will contain information regarding elevation, a digital elevation model, or reflectance of a particular wavelength of light, Landsat, or other electromagnetic spectrum indicators.

Digital elevation model, map (image), and vector data
Raster data type consists of rows and columns of cells, with each cell storing a single value. Raster data can be images (raster images) with each pixel (or cell) containing a color value. Additional values recorded for each cell may be a discrete value, such as land use, a continuous value, such as temperature, or a null value if no data is available. While a raster cell stores a single value, it can be extended by using raster bands to represent RGB (red, green, blue) colors, colormaps (a mapping between a

thematic code and RGB value), or an extended attribute table with one row for each unique cell value. The resolution of the raster data set is its cell width in ground units.

Raster data is stored in various formats; from a standard file-based structure of TIF, JPEG, etc. to binary large object (BLOB) data stored directly in a relational database management system (RDBMS) similar to other vector-based feature classes. Database storage, when properly indexed, typically allows for quicker retrieval of the raster data but can require storage of millions of significantly sized records.

Vector

In a GIS, geographical features are often expressed as vectors, by considering those features as geometrical shapes. Different geographical features are expressed by different types of geometry:

Points

A simple vector map, using each of the vector elements: points for wells, lines for rivers, and a polygon for the lake.

Zero-dimensional points are used for geographical features that can best be expressed by a single point reference — in other words, by simple location. Examples include wells, peaks, features of interest, and trailheads. Points convey the least amount of information of these file types. Points can also be used to represent areas when displayed at a small scale. For example, cities on a map of the world might be represented by points rather than polygons. No measurements are possible with point features.

Lines or polylines

One-dimensional lines or polylines are used for linear features such as rivers, roads, railroads, trails, and topographic lines. Again, as with point features, linear features displayed at a small scale will be represented as linear features rather than as a polygon. Line features can measure distance.

Polygons

Two-dimensional polygons are used for geographical features that cover a particular area of the earth's surface. Such features may include lakes, park boundaries, buildings, city boundaries, or land uses. Polygons convey the most amount of information of the file types. Polygon features can measure perimeter and area.

Each of these geometries is linked to a row in a database that describes their attributes. For example, a database that describes lakes may contain a lake's depth, water quality, pollution level. This information can be used to make a map to describe a particular attribute of the dataset. For example, lakes could be coloured depending on level of pollution. Different geometries can also be compared. For example, the GIS could be used to identify all wells (point geometry) that are within one kilometer of a lake (polygon geometry) that has a high level of pollution.

Vector features can be made to respect spatial integrity through the application of topology rules such as 'polygons must not overlap'. Vector data can also be used to represent continuously varying phenomena. Contour lines and triangulated irregular networks (TIN) are used to represent elevation or other continuously changing values. TINs record values at point locations, which are connected by lines to form an irregular mesh of triangles. The face of the triangles represent the terrain surface.

4. Discuss various types Vector GIS models

Answer: Vector data structures allow the representation of geographic space in an intuitive way reminiscent of the familiar analog map. The geographic space can be represented by the spatial location of items or attributes which are stored in another file for later access. Like raster spatial data model, there are many potential vector data models that can be used to store the geometric representation of entities in the computer.

A point is the simplest spatial entity that can be represented in the vector world with topology. A point requires to be topologically correct with represent to a geographical reference system which locates it with respect to other special entities. To have topology a line entity must consist of an order set of number points with a defined start and end points. Knowledge of the start and end points gives a line direction. For the creation of topologically correct area entities, the data about the points and lines used in its construction, and knowledge of how these are connected to define the boundary, are required.

There are several ways in which vector data structures can be put together into a vector data model by which the relationship between variables in a single coverage or among variable in different coverages can be defined. The two basic types of vector data models are

- Spaghetti Model
- Topological model.

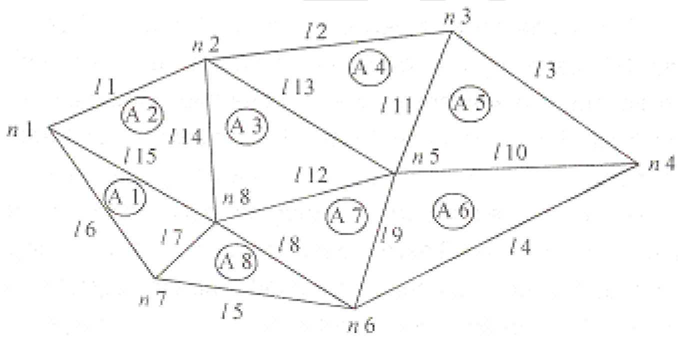
Spaghetti Model:
The simplest vector data structure that can be used to reproduce a geographical image in the computer is a file containing (x,y) coordinate pair that represent the location of individual point features. Fig is essentially a one –for-one translation of the graphical image or a map which is also termed as the conceptual model. Let us consider a conceptual model in which an analog map covering each graphic object is shown in fig. Each graphic object can be represented with a piece of spaghetti. Each piece of spaghetti acts as a single entity. The shortest spaghetti can be represented as a point, collection of a number of point spaghettis for a line entity and collections of line segments that come together at the beginning and ending of surrounding areas from an area entity. Each entity is a single, location recorded in the computer coded as variable length strings of (x,y) coordinate pairs. Let us assume that two polygons lie adjacent to each other in a thematic coverage. These two adjacent polygons must have separate pieces of spaghetti. Each side of polygon is uniquely defined by its own set of lines and

coordinate pairs. In this model of representing vector data, all the spaghettis are recorded separately for polygons. But in the computer they should have the same coordinates.

Topological Models:
In order to use the data manipulation and analysis subsystem more efficiently and obtained the desired result, to allow advanced analytical techniques on GIS data and its systematic study in any project area, much explicit spatial information is to be created. The topological data model incorporates solutions to some of the frequently used operations in advanced GIS analytical techniques. This done by explicitly recording adjacency informing into the basic logical entity in topological data structures, beginning and ending when it contacts or intersects another line, or when there is a change in the direction of the line. Each line then has two sets of numbers: a pair of coordinates and an associated node number. The node is the intersection of two or more lines, and its number is to any line to which it is connected. In addition, each line segment, called a link , has its own identification number that is used as a pointer to indicate the set of nodes that represent its beginning and ending polygon. These links also have identification codes that relate polygon number to see which two polygons are adjacent to each other along its length. In fact the left and right polygons arte also stored explicitly so that even this tedious step is eliminated. This design features allow the computer to know the actual relationship among all its graphical parts to identify the special relationships contained in an analog map document.

There are a number of topological vector data models. Out of the available models there is very common use. These are models are:

- GBF/DIME model created by US department of commerce 1969.
- TIGER model 1986.
- POLYVERT 1984.



Topological vector Data Model.

5. a. Describe the storage of vector data and attribute data.
b. Write short notes on Raster data (10+6)

Answer:

(a): Vector data storage: Vector methods may impose subjective and inexact structure on the landscape, but are more suited to situations where there is a need for precise co-ordinates storage. Important topological information may also be encoded which is very hard to record using raster data structures. The recording of socioeconomic phenomena has generally employed vector techniques, due to the precise nature of the boundaries used for (e.g.) census area definition. A difficulty arises because the precise encoding relates only to the boundaries themselves, and not to the phenomena on which they have been imposed.

In vector representations, an explicit definition is made between the locations of the special entities and the non-spatial attributes of these entities. As mentioned above, these two types of characteristics are frequently held in separate database structures, although some recent work has sought to remove this conventional distinction by database integration. One of the major turnkey GIS packages, ARC/INFO, actually comprises ARC, a special database and manipulation package, and INFO, a commercial DBMS. The independence of the two sub systems is further illustrated by the ability to make alternative software combinations such as ARC/ORACLE. Other turnkey systems, such as Genamap, were designed to provide special data manipulation power which may be built on to an existing relational DBMS (RDBMS), using Structured Query Language (SQL) interfaces (Ingram and Phillips 1987)

(b): Raster data: Raster data is a grid of cells covering an area of interest. Each pixel, the smallest unit of information in the grid, displays a unique attribute.

An example of raster data is a scanned image or photograph. A line drawn in a raster format must be defined by a group of pixels along the length of the line. As a result the size of a raster file is larger than that required by a vector file.

Raster Representation Of Data:

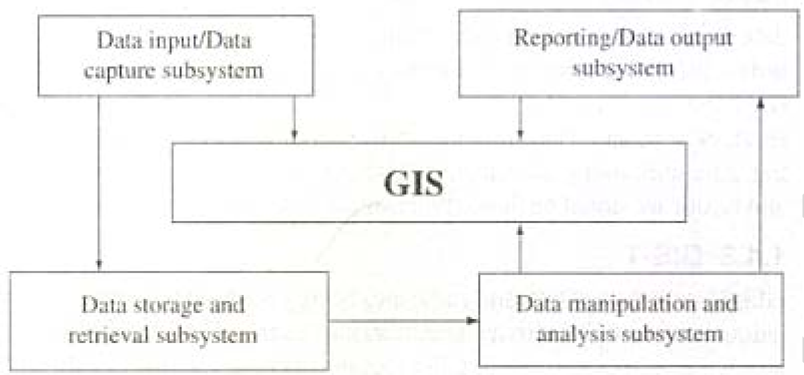
Raster is a method for the storage, processing and display of spatial data. Each area is divided into rows and columns, which form a regular grid structure. Each cell must be rectangular in shape, but not necessarily square. Each cell within this matrix contains location co-ordinates as well as an attribute value. The spatial location of each cell is implicitly contained within the ordering of the matrix, unlike a vector structure which stores topology explicitly. Areas containing the same attribute value are recognised as such, however, raster structures cannot identify the boundaries of such areas as polygons.

Raster data is an abstraction of the real world where spatial data is expressed as a matrix of cells or pixels with spatial position implicit in the ordering of the pixels. With the raster data model, spatial data is not continuous but divided into discrete units. This makes raster data particularly suitable for certain types of spatial operation, for example overlays or area calculations.

Raster structures may lead to increased storage in certain situations, since they store each cell in the matrix regardless of whether it is a feature or simply 'empty' space.

6. a. Explain about GIS data manipulation and analysis.
b. Write short notes on GIS data input and editing. (10+6)

Answer:
(a):



GIS architecture/GIS subsystems

Data Storage and Retrieval: The data storage and retrieval subsystem organizes the data, special and attribute in a form which permits it to be quickly retrieved by the user for analysis, and permits rapid and accurate updates to be made to the data base. This component usually involves the use of a database management system (DBMS) for maintaining attribute data. Spatial data is usually encoded and maintained in a proprietary file format.

Data Manipulation and Analysis: The data manipulation and analysis subsystem allows the user to define and execute special and attribute procedures to generate derived information. This subsystem is commonly thought of as the heart of a GIS, and usually distinguishes it from other database information systems and computer-aided drafting (CAD) systems.

(b): Data Input: The data input system allows the user to capture, collect, and transform special and thematic data into digital form. The data inputs are usually derived from a combination of hardcopy maps, aerial photographs, remotely sensed images, reports and survey documents.

Data editing: The storage and editing subsystem of GIS provides a valley of tools for storing and maintaining the digital representation of study area. It also provides tools for examining each coverage for mistakes that may have crept into our preparations. The input data that is encoding may consist of a number of errors derived from the original data source as well as errors that have been introduced during the encoding process. There may be errors in co-ordinate data as well as in accuracies and uncertainty in attribute data. Before successfully using the methods of data analysis for any specific application, it is better to intercept errors before they contaminate the GIS database. The process of detecting and removing errors through editing is called **cleaning**.

7. a. Explain the integrated analysis of spatial and attribute data.
b. Describe the basic elements of image interpretation. (10+6)

Answer:
(a): The spatial analysis process
The spatial analysis is composed by a set of chained procedures whose aim is to choose an inferential model that explicitly considers the spatial relationship present in the phenomenon. The initial procedures of analysis include the set of generic methods of exploratory analysis and the visualization of data, in general through maps. These techniques permit the description of the distribution of the variables of study, the identification of observations that are outliers not only in relation to the type of distribution but also in relation to its neighbors, and to look for the existence of patterns in the spatial distribution. Through these procedures it is possible to propose hypothesis about the observations, in a way of selecting the best inferential model supported by the data.

The spatial inferential models are usually presented in three great groups: continuous variation, discrete variation, and the point processes. The resolution of a spatial problem may involve the utilization of one of them or the interaction of some or even all of them. The example below illustrates the differences among these models, how they can be used and how they interact inside the same process where questions, based on real facts, must be responded.
Visceral Leishmaniasis is basically an animal disease but that also affects humans. The dogs are the main domestic reservoirs of the urban disease and there is no treatment for them. The disease is spread by mosquitoes, which reproduce in the soil and in decomposing organic matter, like banana trees and fallen leaves. In the last years there were some epidemic outbreaks in Brazilian cities like Belo Horizontal, Aracatuba, Cuiaba, Teresina, and Natal. The control of the disease is based on the combat against the insect and on the elimination of affected dogs inside the disease focus, an area of 200 meters around the human or canine case.

(b) Basic elements of image interpretation:
(i) Tone: Ground objects of different color reflect the incident radiation differently depending upon the incident wave length, physical and chemical constituents of the objects. The imagery as recorded in remote sensing is in different shades or tones.

(ii) Texture: Texture is an expression of roughness or smoothness as exhibited by the imagery. It is the rate of change of tonal values. Texture can qualitatively be expressed as course, medium and fine. The texture is a combination of several image characteristics such as tone, shadow size, shape and pattern etc., and is produced by a mixture of features too small to be seen individually because the texture by definition is the frequency of tonal changes.

(iii) Association: The relation of a particular feature to its surroundings is an important key to interpretation. Some times a single featured by itself may not be distinctive enough to permit its identification.

(iv) Shape: Some ground features have typical shapes due to the structure or topography. For example air fields and football stadium easily can be interpreted because of their finite ground shapes and geometry whereas volcanic covers, sand, river terraces, cliffs, gullies can be identified because of their characteristic shape controlled by geology and topography.

(v) Size: The size of an image also helps for its identification whether it is relative or absolute. Sometimes the measurements of height (as by using parallax bar) also gives clues to the nature of the object.

(vi) Shadows: shadows cast by objects are sometimes important clues to their identification and interpretation. For example, shadow of a suspension bridge can easily be discriminated from that of cantilever bridge. Similarly circular shadows are indicative of coniferous trees.

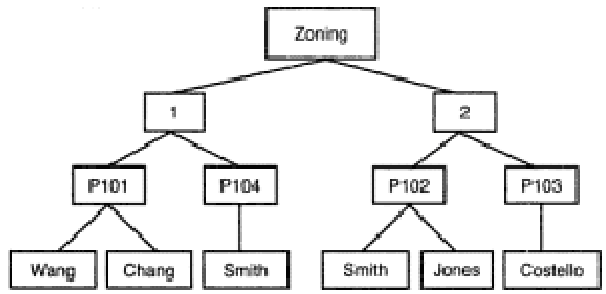
(vii) Size factor or topographic location: Relative elevation or specific location of objects can be helpful to identify certain features. For example, sudden appearance or disappearance of vegetation is a good clue to the underlying soil type or drainage conditions.

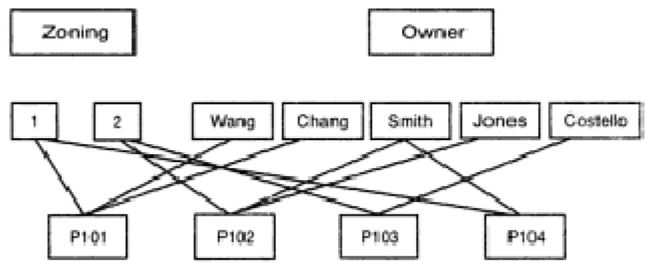
(viii) Pattern: Pattern is the orderly special arrangement of geological topographic or vegetation features. This special arrangement may be two-dimensional or 3-dimensional.

8. a. Explain the types of database design for GIS.
b. Write the quad tree representation. (11+5)

Answer:
(a): Types of database design for GIS: A database is a collection of interrelated tables in digital format. There are at least four types of data base designs that have been proposed in the literature: flat file, hierarchical, network, and relational.

A flat file contains all data in a large table. A feature attribute table is like a flat file. Another example is a spreadsheet with data only. A hierarchical database organizes its data at different levels and uses only the one-to-many association between levels. The simple example is shown in fig.





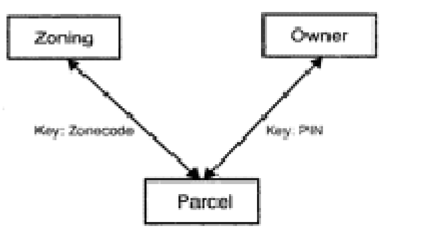


Fig shows us hierarchical levels of zoning, parcel, and owner. Based on the one-to-many association, each level is divided into different branches. A network data builds connections across tables, shown in fig. A common problem with both the hierarchical and network database designs is that the linkages between tables must be known in advance and built into the database at design time. This requirement tends to make a complicated and flexible database and limit the database applications.

A relational database and limit the database applications. GIS vendors typically use the relational model for database, management. A relational database can be connected to each other by keys. A primary key represents one or more attributes whose values can uniquely identify a record in a table. Its counterpart in another table for the purpose of linkage is called foreign key.

(b): Quad tree: The final method of compact storage is a rather difficult approach. Still at least one commercial system called Spatial Analysis System (SPANS), from Tydac, and one experimental system called Quilt are based on this scheme. Like block codes, quadtrees operate on square groups of cells. In this the entire map is successively divided into uniform square groups of cells with the same attribute value. Starting with the entire map as entry points the map is then divided into four quadrants (NW,NE,SW,SE). If any of these quadrants is homogenous containing grid cells with the same value, that quadrant is stored and no further divided into four quadrants, again

NW, NE,SW and SE. Each quadrant is examined for homogeneity. All homogenous quadrants are again stored, and each of the remaining quadrants is further divided and tested in the same way until the entire map is stored, as square groups of cells, each with the same attribute value. In the quadtree structure, the smallest unit of representation is a single grid cell.