SCHEME

SUBJECT: **REMOTE SENSING AND GIS**

EXAM: **¾ B.TECH REGULAR, NOV 2018**

CODE: **14CE506/A**

DEPT: **CIVIL ENGINEERING**

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1. **Answer all questions** **1X12=12**

A) What is active sensor?

Energy is generated and sent from the remote sensing platform towards the targets. The energy reflected back from the targets are recorded using sensors on-board.

B) Abbreviate NASA & NNRMS.

NASA: NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NNRMS: NATIONAL NATURAL RESOURCES MANAGEMENT SYSTEM

C) Define spatial resolution?

Spatial resolution is a measure of the area or size of the smallest dimension on the Earth's surface over which an independent measurement can be made by the sensor.

D) What is geosynchronous orbit?

Geosynchronous orbit is the one in which the time required for the satellite to cover one revolution is the same as that for the Earth to rotate once about its polar axis. In order to achieve this orbit period, geo-synchronous orbits are generally at very high altitude; nearly 36,000 km.

E) List few metrological satellites?

INSAT SERIES, GOES SERIES, GMS

F) What is digital image processing?

It is the use of computer algorithms to perform image processing on digital images. For that, the data must be recorded and available in a digital form suitable for storage on a computer tape or disc.

G) What are the alternate softwares used for GIS?

Arc gis, Arc info, Q-gis etc

H) Define land use & Landover?

Land use: it refers to the purpose the land serves or utilised. E.g.: agriculture, recreation etc.

Landover: it refers to the surface cover on the ground. E.g.: water bodies, bare soil, urban Infrastructure etc.

I) what is ERDAS?

It is an image processing software package that allows users to process both geospatial and other imagery as well as vector data. It can also handle hyperspectral imagery and LIDAR from various sources.

J) What is buffering?

A buffer is zone around a map feature measured in units of distance or time. It is useful in proximity analysis.

k) What is map projection?

It is a systematic transformation of the latitudes and longitudes of locations from the surface of a spheroid or an ellipsoid into locations on a plane. It is also known as cartographic projection.

l) What is topology?

It is defined as the spatial relationships between adjacent or neighbouring features.it is a set of rules and behaviours that model how points, lines and polygons share coincident geometry.

UNIT-I

2. a) discuss the importance of remote sensing in civil engineering? - 6M

The rapid technological advances in the scientific area of Remote Sensing have attracted the interest of several sciences, including civil engineering, regarding the basic principles, methods and applications that may offer a rich source of information valuable to a wide range of issues.

Regarding civil engineering science, Remote Sensing may offer a wide area of applications covering the main fields of interest of a civil engineer as:

- **Regional planning and urban development,**
- **Water resources and hydrological models, site investigations (recording changes or movements etc.),**
- **Study of natural hazards and environmental issues (landslides-floods-earthquakes),**
- **Road alignment studies,**
- **Landover/land use studies,**
- **Solid waste management,**
- **Monitoring of monuments and historical centres,**
- **Environmental impact assessment etc.**

In particular for the specific research, a suitable study area was selected and the appropriate satellite data were collected. As a next step, an investigation of various methods of digital processing of satellite images was done (enhancement, fusion, and classification) and the results were evaluated statistically, as well as in combination with visual image interpretation. With the help of remote sensing and gis much clearer, faster and holistic details of the targeted area can be obtained easily.

2. b) explain different types of satellite orbits? 6M

The path followed by a satellite in the space is called the orbit of the satellite. Orbits may be circular (or near circular) or elliptical in shape. There are three basic types of orbits in use.

- **Geo-synchronous orbits**
- **Polar or near polar orbits**
- **Sun-synchronous orbits**

Geostationary or geosynchronous orbit is the one in which the time required for the satellite to cover one revolution is the same as that for the Earth to rotate once about its polar axis. In order to achieve this orbit period, geo-synchronous orbits are generally at very high altitude; nearly 36,000 km.Geo-synchronous orbits are located in the equatorial plane, i.e with an inclination of 180 degrees. Thus from a point on the equator, the satellite appears to be stationary. The satellites revolve in the same direction as that of the Earth (west to East). Example: INSAT, MeteoSAT, GOES, GMS etc.

Polar orbits are usually medium or low orbits (approximately 700-800km) compared to the geo-synchronous orbits. Consequently the orbit period is less, which typically varies from 90-103 minutes. Therefore satellites in the polar orbits make more than one revolution around the earth in a single day i.e. multiple orbits. The National Oceanic and Atmospheric Administration (NOAA) series of satellites like NOAA 17, NOAA 18 are all examples of polar orbiting satellites.

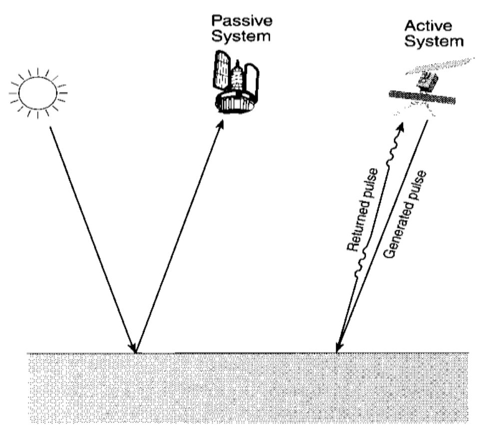
Taking advantage of the rotation of the earth on its own axis, each time newer segments of the Earth will be under view of the satellite. The satellite's orbit and the rotation of the Earth work together to allow complete coverage of the Earth's surface, after it has completed one complete cycle of orbits.

Sun-synchronous orbits is a special case of polar orbit. Like a polar orbit, the satellite travels from the north to the south poles as the Earth turns below it. In a sun-synchronous orbit, the satellite passes over the same part of the Earth at roughly the same local time each day. These orbits are between 700 to 800 km altitudes. These are used for satellites that need a constant amount of sunlight.

3. a) what are the types of sensor systems? Explain 6M

Depending on the source of electromagnetic energy, remote sensing can be classified as passive or active remote sensing.
In the case of **passive remote sensing**, source of energy is that naturally available such as the Sun. Most of the remote sensing systems work in passive mode using solar energy as the source of EMR. Solar energy reflected by the targets at specific wavelength bands are recorded using sensors on-board air-borne or space borne platforms.

In the case of **active remote sensing**, energy is generated and sent from the remote sensing platform towards the targets. The energy reflected back from the targets are recorded using sensors on-board the remote sensing platform. Most of the microwave remote sensing is done through active remote sensing.



3. b) list out the important Indian satellites and their salient features. 6M

Table 8. Details of the various satellites of the IRS satellite program

Satellite	IRS-1A	IRS-1B	IRS-1C	IRS-1D	IRS-P2	Cartosat-2	Resourcesat-2
Period	1988-1996	1991-2003	1995-2007	1997-2010	2003-	2007-	2011-
Orbit	Sun-synchronous, Polar						
Eq. crossing	10:30am						
Altitude	904		817		817	630	822
Inclination	99.08		98.6		98.7	97.91	98.73
Repeat cycle (days)	22		24		24 LISS-4 and AWiFS : 5	310 Revisit: 4	24
Sensors	LISS-1, LISS-2A and 2B		PAN, LISS-3, WiFS		LISS-3 and 4, AWiFS	PAN camera	LISS-3 and 4, AWiFS
Bands	B1-B4		PAN, LISS-3 B1-B4 WiFS B1-B2		LISS-3 B1-B4 LISS-4 B1-B3 AwiFS B1-B4	PAN (0.5-0.85μm)	LISS-3 B1-B4 LISS-4 B1-B3 AwiFS B1-B4
Spatial resolution	72.5m	36.25m	PAN:5.8m LISS-3: 23m (B4:70m)		LISS-3:23.5 LISS-4: 5.8 AWiFS: 56m	0.81m	LISS-3:23.5 LISS-4: 5.8 AWiFS: 56m
Radiometric resolution (Bits)	7	7	7	7	LISS-3 and 4: 7 AwiFS: 10	10	LISS-3 and 4: 10 AwiFS: 12

Table 7. Spectral bands used in various sensors of the IRS satellites

Sensor	LISS-1 and 2	LISS-3	LISS-4	WiFS	AWiFS
Wavelength bands (μm)	0.45-0.52	0.52-0.59	0.52-0.59	0.62-0.68	0.52-0.59
	0.52-0.59	0.62-0.68	0.62-0.68	0.77-0.86	0.62-0.68
	0.62-0.68	0.77-0.86	0.77-0.86		0.77-0.86
	0.77-0.86	1.55-1.70			1.55-1.70

4. a) what is image interpretation ? Explain different types of visual interpretation. 6M

Analysis of remote sensing imagery involves the identification of various targets in an image, and those targets may be environmental or artificial features, which consist of points, lines, or areas.

This radiation is measured and recorded by a sensor, and ultimately is depicted as an image product such as an Observing the differences between targets and their backgrounds involves comparing different targets based on any, or all, of the visual elements of

- **Tone** refers to the relative brightness or colour of objects in image. Generally, tone is the Fundamental element for distinguishing between different targets or features.
- **Shape** refers to the general form, structure, or outline of individual objects. Shape can be a very distinctive clue for interpretation.
- **Size** of objects in an image is a function of scale. It is important to assess the size of a target relative to other objects in a scene, as well as the absolute size, to aid in the interpretation of that target.
- **Pattern** refers to the spatial arrangement of visibly discernible objects. Typically an orderly Repetition of similar tones and textures will produce a distinctive and ultimately recognizable pattern.

- **Texture** refers to the arrangement and frequency of tonal variation in particular areas of an image. Rough textures would consist of a mottled tone where the grey levels change abruptly in a small area, Smooth textures are most often result of uniform, even surfaces.
- **Shadow** is also helpful in interpretation as it may provide an idea of the profile and relative height of a target or targets which may make identification easier.
- **Association** takes into account the relationship between other recognizable Objects or features in proximity to the target of interest.

4. b) explain on the different types of interactions of EMR with atmosphere. 6M

There are three different types of scattering:

Rayleigh scattering mainly consists of scattering caused by atmospheric molecules and other tiny particles. This occurs when the particles causing the scattering are much smaller in diameter (less than one tenth) than the wavelengths of radiation interacting with them.
Smaller particles present in the atmosphere scatter the shorter wavelengths more compared to the longer wavelengths.
The scattering effect or the intensity of the scattered light is inversely proportional to the fourth power of wavelength for Rayleigh scattering. Hence, the shorter wavelengths are scattered more than longer wavelengths.

Mie scattering which occurs when the wavelengths of the energy is almost equal to the diameter of the atmospheric particles. In Mie scattering, intensity of the scattered light varies approximately as the inverse of the wavelength.
Mie scattering is usually caused by the aerosol particles such as dust, smoke and pollen. Gas molecules in the atmosphere are too small to cause Mie scattering of the radiation commonly used for remote sensing.

Non-selective scattering which occurs when the diameters of the atmospheric particles are much larger (approximately 10 times) than the wavelengths being sensed. Particles such as pollen, cloud droplets, ice crystals and raindrops can cause non-selective scattering of the visible light.

5. a) what is GIS? Explain various components of GIS. 6M

Geographical Information Systems have four important components, namely,

- **computer hardware,**
- **sets of application software modules**
- **data(spatial & attribute)**
- **People**, (and a proper organisational setup.)

These four components need to be in balance if the system is to function satisfactorily. GIS run on the whole spectrum of computer systems ranges from portable personal computers to multi-user supercomputers, and are programmed in a wide variety of software packages. Systems are available that use dedicated and expensive work stations, with monitors and digitising tables built in. In all cases, there are a number of elements that are essential for effective GIS operations. These include

- The presence of a processor with sufficient power to run the software
- Sufficient memory for the storage of large volumes of data
- A good quality, high resolution colour graphics screen and
- Data input and output devices, like digitisers, scanners, keyboards, printers & plotters.
- Professionally skilled persons required to work on gis.

5. b) what is map projection ? Explain different types of map projections? 6M

A map projection is one of many methods used to represent the 3-dimensional surface of the earth or other round body on a 2-dimensional plane in cartography (mapmaking).

Map Projection classification is based on type of projection surface that is used. The projections are described in terms of placing a gigantic planar surface in contact with the earth, followed by an implied scaling operation. These surfaces are classified as

- **Cylindrical (exm. Mercator projection),**
- **Conic (exm. Albers projection),**
- **Azimuthal or plane (polar region projections).**

Cylindrical projection equations yield projected graticules with straight meridians and parallels that intersect at right angles. The example shown above is a Cylindrical Equidistant (also called Plate Carrée or geographic) in its normal equatorial aspect.

Conic projections yield straight meridians that converge toward a single point at the poles, parallels that form concentric arcs. The example shown above is the result of an Albers Conic Equal Area, which is frequently used for thematic mapping of mid-latitude regions.

Planar projections also yield meridians that are straight and convergent, but parallels form concentric circles rather than arcs. Planar projections are also called azimuthal because every planar projection preserves the property of azimuthally, directions (azimuths) from one or two points to all other points on the map. The projected graticule shown above is the result of an Azimuthal Equidistant projection in its normal polar aspect.

6. a) explain different types of data models in GIS? 6M

GIS data can be separated into two categories:

- **Spatially referenced data** which is represented by vector and raster forms (including imagery)
- **Attribute data** tables which is represented in tabular format.

Within the spatial referenced data group, the GIS data can be further classified into two different types:

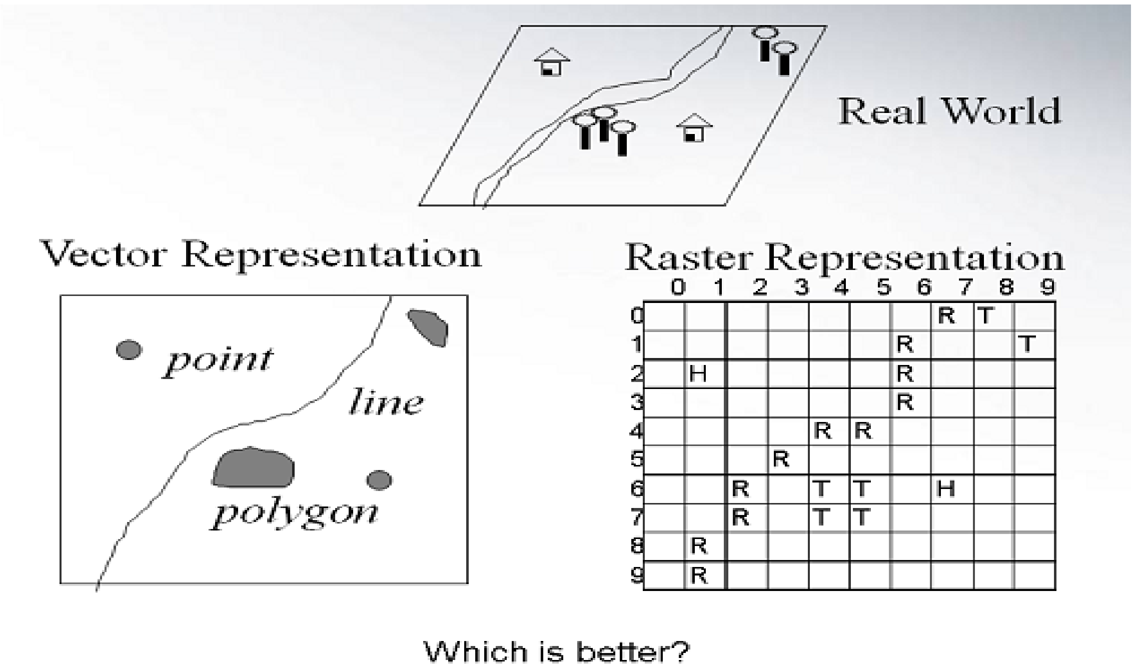
- **vector data**
- **raster data**

Vector data

Vector data is split into three types: polygon, line (or arc) and point data. Polygons are used to represent areas such as the boundary of a city (on a large scale map), lake, or forest. Polygon features are two dimensional and therefore can be used to measure the area and perimeter of a geographic feature..

Raster Data

Raster data (also known as grid data) represents the fourth type of feature: surfaces. Raster data is cell-based and this data category also includes aerial and satellite imagery. There are two types of raster data: continuous and discrete. An example of discrete raster data is population density. Continuous data examples are temperature and elevation measurements. There are also three types of raster datasets: thematic data, spectral data, and pictures (imagery).



6. b) what is vector data. Explain the advantages of vector data model? 6M

Vector data

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Advantages :

- Data can be represented at its original resolution and form without generalization.
- Graphic output is usually more aesthetically pleasing (traditional cartographic representation);
- Since most data, e.g. hard copy maps, is in vector form no data conversion is required.
- Accurate geographic location of data is maintained.
- Allows for efficient encoding of topology, and as a result more efficient operations that require topological information, e.g. proximity, network analysis.

7. a) discuss different data input methods in GIS. **6M**

Data input is the procedure of encoding data into a computer-readable form and writing the data to the GIS data base. There are two types of data to be entered in a GIS

- spatial (geographic location of features) and
- Non-spatial (descriptive or numeric information about features).

There are three types of data entry:

- **Manual (via typing on keyboard or importing text files);**
- **Digitizing;**
- **Scanning;**

Manual data entry can bring into GIS either collected or measured data. These data exist as simple text files or binary files. Text files should have at least two columns with X and Y coordinates. These columns allow georeferencing of the file i.e. association of it with specific geographic coordinate system. Binary files are usually a product of the software package associated with measuring device (for example files from Global Positioning System data collection). They also have X and Y data, associated with description of the collected features, but in encoded format that could be read by special software.

Digitizing is a process of entering digital codes of analysed data into computer. Digitizing can be manual (using digitizing tablet) or automatic (using scanner). The difference between two methods is that digitizing tablet allows to do georeferencing during the digitizing process,

Scanning require georeferencing later, after digital file (usually TIFF, GIF or JPEG image) has been created. Another difference between methods is speed and accuracy of the data processing. Apparent slowness of the work on digitizing tablet compensates often for the amount of editing after scanning process. At the same time good scanning allows automatic layer separation (for example, separation of red-coloured roads from brown-coloured contour lines), while digitizing of the map on a tablet requires manual creation of separate themes. In this case the condition of the original hardcopy is very important. Since human operator can use more cognitive tools and knowledge than the software support for scanning device, digitizer can handle better the hardcopy in a poor condition. Special kind of scanned data is remote sensing image, taken either by satellite camera, digital camera or video camera.

7. b) write short notes on : 1) digitization **6M**

2) Scanning

1) Digitization: A digitizer is an electronic device consisting of a table upon which the map or drawing is placed. The user traces the spatial features with a hand-held magnetic pen, often called a mouse or cursor. While tracing the features the coordinates of selected points, e.g. vertices, are sent to the computer and stored. All points that are recorded are registered against positional control points, usually the map corners that are keyed in by the user at the beginning of the digitizing session. The coordinates are recorded in a user defined coordinate system or map projection. Latitude and longitude and UTM is most often used. The ability to adjust or transform data during digitizing from ne projection to another is a desirable function of the GIS software. Numerous functional techniques exist to aid the operator in the digitizing process.

Digitizing can be done in a point mode, where single points are recorded one at a time, or in a stream mode, where a point is collected on regular intervals of time or distance, measured by an X and Y movement, e.g. every 3 metres. Digitizing can also be done blindly or with a graphics terminal. Blind digitizing infers that the graphic result is not immediately viewable to the person digitizing. Most systems display the digitized line work as it is being digitized on an accompanying graphics terminal.

2) Scanning: A variety of scanning devices exist for the automatic capture of spatial data. While several different technical approaches exist in scanning technology, all have the advantage of being able to capture spatial features from a map at a rapid rate of speed. However, as of yet, scanning has not proven to be a viable alternative for most GIS implementation. Scanners are generally expensive to acquire and operate. As well, most scanning devices have limitations with respect to the capture of selected features, e.g. text and symbol recognition. Experience has shown that most scanned data requires a substantial amount of manual editing to create a clean data layer.

Consensus within the GIS community indicates that scanners work best when the information on a map is kept very clean, very simple, and uncluttered with graphic symbology. The sheer cost of scanning usually eliminates the possibility of using scanning methods for data capture in most GIS implementations. Large data capture shops and government agencies are those most likely to be using scanning technology.

8. a) explain various applications of GIS in civil engineering? 6M

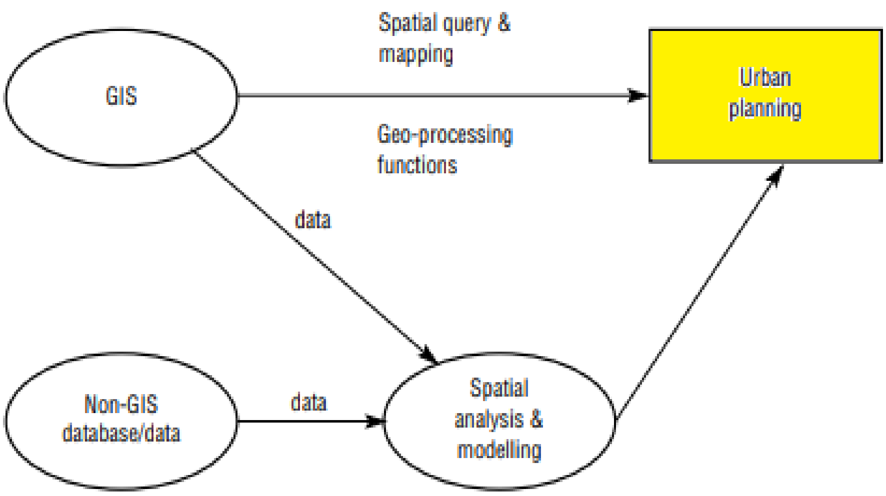
Remote sensing and GIS techniques become potential and indispensable tools for solving many problems of civil engineering. Remote sensing observations provides data on earth‘s resources in a spatial format, GIS co-relates different kinds of spatial data and their attribute data, so as to use them in various fields of civil engineering.

- Water distribution analysis
- Town Planning and Urban Development
- Structural Health Monitoring (SHM)
- Traffic management analysis
- Soil analysis
- Site feasibility analysis
- Environment impact analysis
- Examples of hydrological applications include:
- wetlands mapping and monitoring,
- soil moisture estimation,
- snow pack monitoring / delineation of extent,
- measuring snow thickness,
- determining snow-water equivalent,
- river and lake ice monitoring,
- flood mapping and monitoring,
- glacier dynamics monitoring (surges, ablation)

- river /delta change detection
- drainage basin mapping and watershed modelling
- irrigation canal leakage detection
- irrigation scheduling
- River or canals pattern analysis
- Temperature and humidity analysis

8. b) explain the use of GIS in physical transformation of urban land. 6M

- GIS provides planners, surveyors, and engineers with the tools they need to design and map their neighbourhoods and cities. Visualization, spatial analysis, and spatial modelling are the most frequently used GIS functions in plan making. GIS can help to store, manipulate, and analyse physical, social, and economic data of a city. Planners can then use the spatial query and mapping functions of GIS to analyse the existing situation in the city. Through map overlay analysis, GIS can help to identify areas of conflict of land development with the environment by overlaying existing land development on land suitability maps.
- Using the multi-layered mapping feature of GIS, a municipal planning committee can visualize a variety of things, for instance, prime agricultural land, surface water, high flood frequency, and highly erodible land. This information leads to informed decisions such as avoiding developing areas with high flood frequency as those areas are not likely to attract dwellers.
- GIS can significantly aid in monitoring an area or conducting a feasibility study of a location for a specific purpose, for instance ascertaining the suitability of a location for the construction of a bridge or dam.
- Feasibility studies of smaller structures like schools and hospitals can also be carried out effectively using GIS. It can also be used to ascertain the feasibility of an area for waste disposal and treatment.
- GIS also helps in identifying changes in geographical features or behaviour a land over a specified time. Such information enables professionals to make informed decisions about the development condition of an area and plan accordingly.



9. a) how GIS is useful in ground water targeting? 6M

Ground water is a precious and the most widely distributed resource of the earth and unlike any other mineral resource, it gets its annual replenishment from the meteoric precipitation. It is the largest source of fresh water on the planet excluding the polar icecaps and glaciers. The only recharge of ground water is precipitation, which is less and erratic. As such often drought conditions persist.

It is essential that each drop of rain water fallen on ground is utilized properly for better water management. Recharge can be effectively done through the construction of mini percolation tanks, sub surface dams and other recharge structures at feasible sites.

Ground water prospects of an area depend mainly on lithology unit (rock type) occurring at that area. However, within each lithology unit, the ground water conditions vary significantly depending upon the

- Geomorphology
- structure
- slope
- soil thickness
- depth and nature of weathered material
- presence of fractures,
- lineaments,
- Surface water bodies, canals, irrigated areas, etc.

All the parameters of the study area are studied and integrated to arrive at the ground water prospects.

9. b) explain various components of GPS? 6M

GPS is a satellite based navigation system used to determine the position of an object. Owned by US, Originally designed for military purposes.

Space segment: The space segment comprises of 24 satellites orbiting the earth at approximately 20200 km every 12 hours. There are 6 orbital planes with nominally four satellite vehicles in each orbit. The space segment is designed in such a way that there will always be a minimum of 4 satellites visible above 15 degrees cut off/mask angle at any point of the earth's surface at any time.

Each of the GPS satellites have highly precise atomic clocks on board which operate at a fundamental frequency of 10.23 MHz These clocks are crucial to generate the signals which are broadcasted from the satellite. Satellites generally broadcast two carrier waves which are in the L band. These carrier waves are usually derived using the fundamental frequency generated by the highly precise atomic clock on-board the satellite.

Control segment: The control segment comprise of a master control station with 5 monitoring stations. These stations track/control the orbital's positions of satellites. The control stations are located at Hawaii, Colorado Springs, Ascension islands, Diego Garcia, Kwajalein.

It is essential to estimate the orbit of each satellite in order to predict its path 24 x 7. This information is available in uploaded to each of these orbiting satellites which are subsequently broadcasted from them. The signals captured by users with a GPS receiver enables to know the exact position of each of these satellites.

The signals from satellites are read at the control stations which estimate the measurement errors. These errors are then transmitted to the master control station in Colorado Springs wherein processing takes place to determine any errors in each of these satellites. This information from the master control station is resent to the four monitoring stations which are then uploaded to these satellites.

User Segment: GPS receivers are used to receive the GPS signals which can then be used for navigation and other purposes. Anyone who avails this facility comprises the user segment.