1. Define GIS. Describe the role of GIS in a mountainous country Nepal. Support your answer with a reference of an application.

Geographic information systems (GIS) (also known as Geospatial information systems) are Computer Software and hardware systems that enable users to capture, store, analyze and manage spatially referenced data. GISs have transformed the way spatial (geographic) data, relationships and patterns in the world are able to be interactively queried, processed, analyzed, mapped, modeled, visualized, and displayed for an increasingly large range of users, for a multitude of purposes. In a general sense, the term describes any information system that integrates stores, edits, analyzes, shares, and displays geographic information. GIS applications are tools that allow users to create interactive queries (user-created searches), analyze spatial information, edit data in maps, and present the results of all these operations. Geographic information science is the science underlying geographic concepts, applications, and systems.

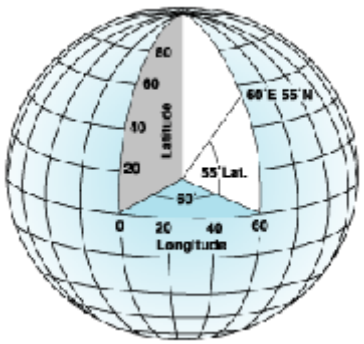
2. What are the various coordinate systems used in GIS applications? Describe them in advantages and disadvantages.

X,Y coordinates are geo referenced with a geographic or projected coordinate system. A geographic coordinate system (GCS) is defined by a datum, an angular unit of measure (usually degrees), and a prime meridian. A projected coordinate system (PCS) consists of a linear unit of measure (usually meters or feet), a map projection, the specific parameters used by the map projection, and a geographic coordinate system. Types of coordinate systems .There are two common types of coordinate systems used in GIS: A global or spherical coordinate system such as latitude–longitude. These are often referred to as geographic coordinate systems.

A projected coordinate system based on a map projection such as transverse Mercator, Albers equal area, or Robinson, all of which (along with numerous other map projection models) provide various mechanisms to project maps of the earth's spherical surface onto a two-dimensional Cartesian coordinate plane. Projected coordinate systems are sometimes referred to as map projections.

A geographic coordinate system (GCS) uses a three-dimensional spherical surface to define locations on the earth. A GCS is often incorrectly called a datum, but a datum is only one part of a GCS. A GCS includes an angular unit of measure, a prime meridian, and a datum (based on a spheroid). The spheroid defines the size and shape of the earth model, while the datum connects the spheroid to the earth's surface.

A point is referenced by its longitude and latitude values. Longitude and latitude are angles measured from the earth's center to a point on the earth's surface. The angles often are measured in degrees (or in grads). The following illustration shows the world as a globe with longitude and latitude values:



In the spherical system, horizontal lines, or east–west lines, are lines of equal latitude, or parallels. Vertical lines, or north–south lines, are lines of equal longitude, or meridians. These lines encompass the globe and form a gridded network called a graticule.

The line of latitude midway between the poles is called the equator. It defines the line of zero latitude. The line of zero longitude is called the prime meridian. For most GCSs, the prime meridian is the longitude that passes through Greenwich, England. The origin of the graticule (0,0) is defined by where the equator and prime meridian intersect.

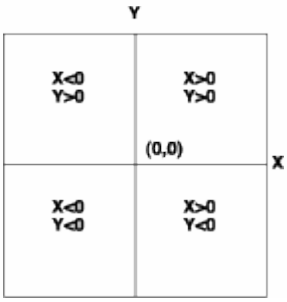
Latitude and longitude values are traditionally measured either in decimal degrees or in degrees, minutes, and seconds (DMS). Latitude values are measured relative to the equator and range from –90° at the south pole to +90° at the north pole. Longitude values are measured relative to the prime meridian. They range from –180° when traveling west to 180° when traveling east. If the prime meridian is at Greenwich, then Australia, which is south of the equator and east of Greenwich, has positive longitude values and negative latitude values.

A projected coordinate system is defined on a flat, two-dimensional surface. Unlike a geographic coordinate system, a projected coordinate system has constant lengths, angles, and areas across the two dimensions. A projected coordinate system is always based on a geographic coordinate system that is based on a sphere or spheroid.

In a projected coordinate system, locations are identified by x,y coordinates on a grid, with the origin at the center of the grid. Each position has two values that reference it to that central location. One specifies its horizontal position and the other its vertical position. The two values are called the x-coordinate and y-coordinate. Using this notation, the coordinates at the origin are x = 0 and y = 0.

On a gridded network of equally spaced horizontal and vertical lines, the horizontal line in the center is called the x-axis and the central vertical line is called the y-axis. Units are consistent and equally spaced across the full range of x and y. Horizontal lines above the origin and vertical lines to the right of the origin have positive values; those below or to the left have negative values. The four quadrants represent the four possible combinations of positive and negative X and Y coordinates.

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



3. What are raster and vector data? Differentiate between their properties with advantages and disadvantages.

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).

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. Polygon features are most commonly distinguished using either a thematic mapping symbology (color schemes), patterns, or in the case of numeric gradation, a color gradation scheme could be used.

There are some important advantages and disadvantages to using a raster or vector data model to represent reality:

- Raster datasets record a value for all points in the area covered which may require more storage space than representing data in a vector format that can store data only where needed.
- Raster data is computationally less expensive to render than vector graphics
- There are transparency and aliasing problems when overlaying multiple stacked pieces of raster images
- Vector data allows for visually smooth and easy implementation of overlay operations, especially in terms of graphics and shape-driven information like maps, routes and custom fonts, which are more difficult with raster data.
- Vector data can be displayed as vector graphics used on traditional maps, whereas raster data will appear as an image that may have a blocky appearance for object boundaries. (depending on the resolution of the raster file)
- Vector data can be easier to register, scale, and re-project, which can simplify combining vector layers from different sources.
- Vector data is more compatible with relational database environments, where they can be part of a relational table as a normal column and processed using a multitude of operators.
- Vector file sizes are usually smaller than raster data, which can be tens, hundreds or more times larger than vector data (depending on resolution).
- Vector data is simpler to update and maintain, whereas a raster image will have to be completely reproduced. (Example: a new road is added).
- Vector data allows much more analysis capability, especially for "networks" such as roads, power, rail, telecommunications, etc. (Examples: Best route, largest port, airfields connected to two-lane highways). Raster data will not have all the characteristics of the features it displays.

4. What are various sources of GIS data? Describe methods of data capture.

The various sources of GIS data can be categories into two types:

The first category is called primary data. Primary data refer to data that are collected directly or on a firsthand basis. For example, if you wanted to examine the variability of local temperatures in the month of May, and you recorded the temperature at noon every day in May, you would be constructing a primary data set.

Secondary data refer to data collected by someone else or some other party. For instance, when we work with census or economic data collected and distributed by the government, we are using secondary data.

Different methods of data capture are as follows:

Manual Data Capture:

In manual data capture process, the data is entered manually by an operator using input devices like keyboard, touch screens, mouse etc. for keying in data in the form of figures or text into particular software such as Excel or any other data or word processing program.

Automated Data Capture:

Automated data capture involves the use of computerized technology to capture data. This method has a high initial cost on account of the initial investment required as for instance, the purchase of technology but as the project proceeds, is found to lower the operating costs significantly on account of low manpower requirement.

Optical Character Recognition (OCR):

OCR technology is used to convert different types of machine-printed documents including image files, PDF files or scanned paper documents, into searchable and editable data.

Intelligent Character Recognition (ICR):

ICR technology helps to recognize and capture handwritten printed characters from image files. As handwritten text caries significantly, so ICR is less accurate and complicated as compared to other technologies

Optical Mark Reading (OMR):

OMR technology is used to capture human marked data from documents such as forms and surveys. The technology has the capacity to differentiate between marked and unmarked boxes and so, is used for capturing data through boxes that are checked manually on documents.

Magnetic Ink character Recognition (MICR):

It is a data capture technology capable of recognizing characters. It involves the recognition of specially formatted characters that are printed in magnetic ink, by a machine.

Magnetic Stripe Cards:

Magnetic stripe cards store data using magnetic properties of certain materials. They possess stripes of iron-based magnetic materials on the card.

Smart-Cards:

Smart cards are pocket-sized cards with embedded integrated circuits. They can function on contact or can be contactless. They contain more memory than magnetic cards and can be used for data related to personal identification, authentication, biometrics etc.

Web-Data Capture:

Data capture from web involves the capture of data from electronic forms through internet or intranet.

Voice- Recognition:

Voice recognition is the process of converting speech into text. The text can be simple text or can be a set of commands.

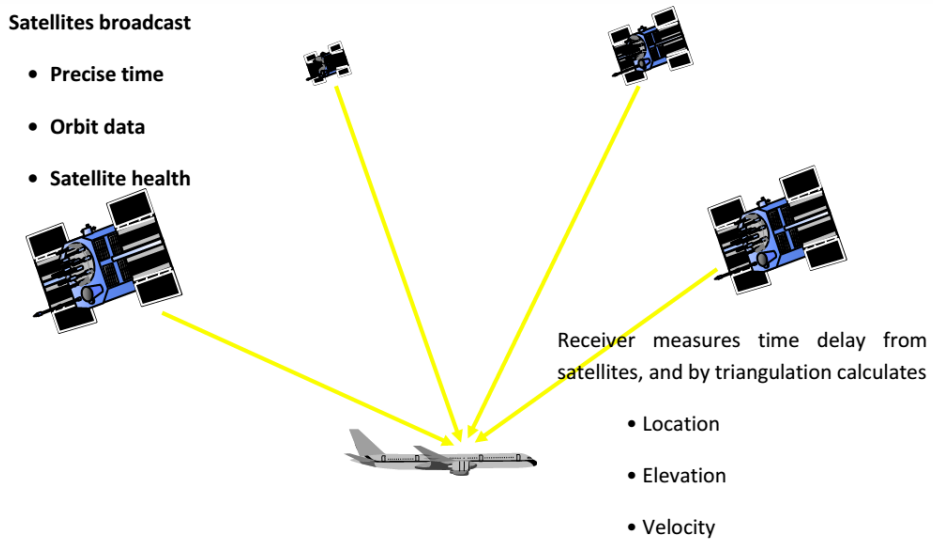
5. What do you mean by spatial analysis? How do you perform the raster overlay operations using relational operators? Explain with example.

Spatial analysis or **spatial statistics** includes any of the formal techniques which study entities using their topological, geometric, or geographic properties. Spatial analysis includes a variety of techniques, many still in their early development, using different analytic approaches and applied in fields as diverse as astronomy, with its studies of the placement of galaxies in the cosmos, to chip fabrication engineering, with its use of "place and route" algorithms to build complex wiring structures. In a more restricted sense, spatial analysis is the technique applied to structures at the human scale, most notably in the analysis of geographic data.

6. What is GPS? How does it work? What are various types of errors related to GPS data?

The GPS (Global Positioning System) is a "constellation" of approximately 30 well-spaced satellites that orbit the Earth and make it possible for people with ground receivers to pinpoint their geographic location. The location accuracy is anywhere from 100 to 10 meters for most equipment. Accuracy can be pinpointed to within one (1) meter with special military-approved equipment. GPS equipment is widely used in science and has now become sufficiently low-cost so that almost anyone can own a GPS receiver.

The GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS receiver how far away the satellite is.
ϖ With four or more satellites in view, the receiver can determine the user's 3D position (latitude, longitude and altitude).



GPS is a system. It's made up of three parts: satellites, ground stations, and receivers. Satellites act like the stars in constellations—we know where they are supposed to be at any given time. The ground stations use radar to make sure they are actually where we think they are. A receiver, like you might find in your phone or in your parents car, is constantly listening for a signal from these satellites. The receiver figures out how far away they are from some of them.

Once the receiver calculates its distance from four or more satellites, it knows exactly where you are. Presto! From miles up in space your location on the ground can be determined with incredible precision! They can usually determine where you are within a few yards of your actual location. More high-tech receivers, though, can figure out where you are to within a few inches.