UNIVERSITY GRANTS COMMISSION

GEOGRAPHY **CODE: 80**

UNIT – 9: GEOGRAPHICAL TECHNIQUES

SYLLABUS

Sub Unit – 1: Maps and Cartography

Sl No.	TOPIC
1	9.1.1 Sources of Geographic Information and Data:
2	9.1.1.1 Spatial data:
3	9.1.1.2 Non-spatial data:
4	9.1.2 Types of Maps:
5	9.1.2.1 Essential characters of a map:
6	9.1.2.1.1 Scale its essentialities:
7	9.1.2.2 Classification of maps:
8	According to purpose :
9	B) According to scale :
10	C)According to function:
11	9.1.3 Techniques of Map Making:
12	9.1.3.1 Choropleth:
13	9.1.3.2 Isopleth:
14	9.1.3.3 Isarithmic:
15	9.1.3.4 Dasymetric:
16	9.1.3.5 Chorochromatic:
17	9.1.3.6 Choroschematic Maps:
18	9.1.3.7 Dot Maps:
19	9.1.3.7 Flow Maps:
20	9.1.4 Data Representation on Maps:
21	9.1.4.1 Pie diagrams:
22	9.1.4.2 Bar diagrams:
23	9.1.4.3 Line Graph:

Sub Unit – 2: GIS and Remote Sensing

Sl. No.	Topic

1	**9.2.1 GIS Database:**
2	**Attribute Data:**
3	**Vector Data:**
4	**Raster Data:**
5	**9.2.2 Functions of GIS:**
6	**9.2.3 Digital Elevation Model (DEM):**
7	**9.2.4 Georeferencing:**
8	**9.2.4.1 Co-ordinate system:**
9	**9.2.4.2 Map projections:**
10	**9.2.4.3 Datum:**
11	**9.2.5 GIS Applications:**
12	**9.2.5.1 Thematic cartography:**
13	**9.2.5.2 Spatial decision support system:**
14	**9.2.6 Basics of Remote Sensing:**
15	**9.2.6.1 Electromagnetic Radiation:**
16	**9.2.6.2 Electromagnetic Spectrum:**
17	**9.2.6.3 Sensors:**
18	**9.2.6.4 Platforms:**
19	**9.2.6.5 Resolution:**
20	**9.2.6.6 Types:**
21	**A. Spatial Resolution**
22	**B. Spectral Resolution**
23	**C. Temporal resolution**
24	D. **Radiometric Resolution**
25	**9.2.7 Elements of Air Photo and Satellite Image Interpretation:**
26	**9.2.7.1 Photogrammetry:**
27	**9.2.7.2 Types of Aerial Photographs:**
28	**9.2.8 Digital Image Processing:**
29	**9.2.9 GPS Components:**
30	**9.2.9.1 GPS applications:**

Sub Unit – 3: Measures of central Tendency

Sl No.	TOPIC
1	**9.3.0 Cetral Tendency**
2	**9.3.1 Mathematical Average**
3	**9.3.2 Positional Average**
4	**9.3.3 Dispersion**

5	9.3.4 Correlation
6	9.3.5 Regression Analysis
7	9.3.6 Hypothesis of Testing
8	9.3.6.1 Types of Hypothesis
9	9.3.6.2 Two Tailed and One Tailed Test of Hypothesis
10	9.3.7 Small Sample Test
11	9.3.8 Time Series Analysis
12	9.3.9 Sampling

Sub Unit – 4: Morphometric Analysis

Sl No.	TOPIC
1	9.4.0 Introduction
2	9.4.1 Morphometry of Drainage Basins

Section – 1: Unit at a Glance

Sub Unit – 1: Maps and Cartography

Cartography is the study and practice of making maps.

Spatial data: Spatial data refers space related data. It refers to shape, size and location of the earth or a part of the earth, such as any administrative boundaries, road and railways,

cities of towns of a country, state or district etc.

Non-spatial data: Non- spatial data refers to other attributes associated with the feature (spatial data) such as name, length, area, volume, population, soil type, etc.

Scale: Scale is a ratio between map distance and ground distance.

Classification of maps:

A) According to purpose:

1. **the 'general-purpose' (or 'reference') map:**
2. **the 'special-purpose' (or 'thematic') map**
   a) **Qualitative maps:**
   b) **Quantitative maps:**

B) According to scale:

1. **Small scale map:**
2. **Medium scale map:**
3. **Large scale map:**

C)According to function:

1. **Physical maps:**
2. **Cultural maps:**

Choropleth: A choropleth map is a type of thematic map in which areas are shaded or patterned in proportion to a statistical variable that represents an aggregate summary of a geographic characteristic within each area, such as population density or per-capita income.

Isopleth: The word Isopleth is derived from Iso meaning equal and pleth means lines. Thus, an imaginary line, which joins the places of equal values, is referred as Isopleth.

Isarithmic: Isarithmic maps, also known as contour maps or isoline maps depict smooth continuous phenomena such as precipitation or elevation.

Dasymetric: The dasymetric map is a type of thematic map that uses areal symbols to visualize a geographic field by refining a choropleth map with ancilliary information about the distribution of the variable.

Chorochromatic: A Chorochromatic map, also known as an area-class or qualitative area maps, is a type of thematic map that portray regions of categorical or nominal data using variations in color symbols.

Choroschematic Maps: Various cartographic symbols like dots, circles, triangles, initial letters of the elements to represent on the map.

Dot Maps: The dot maps are drawn to show the distribution of phenomena such as population, cattle, types of crops, etc. The dots of same size as per the chosen scale are marked over the given administrative units to highlight the patterns of distributions.

Flow Maps: In cartography, **flow maps** are a mix of maps and flow charts, that "show the movement of objects from one location to another, such as the number of people in a migration, the amount of goods being traded, or the number of packets in a network.

Pie diagrams:A pie chart is a circular statistical graphic, which is divided into slices to illustrate numerical proportion. In a pie chart, the arc length of each slice, is proportional to the quantity it represents.

Bar diagrams: A bar chart or bar graph is a chart or graph that presents categorical data with rectangular bars with heights or lengths proportional to the values that they represent.

Line Graph: A line chart or line plot or line graph or curve chart is a type of chart which displays information as a series of data points called 'markers' connected by straight line segments.

Sub Unit – 2: GIS and Remote Sensing

A geographic information system is a conceptualized framework that provides the ability to capture and analyze spatial and geographic data.

Raster Data: A raster data structure is based on a tessellation of the 2D plane into cells.

Vector Data: It is the representation of the points, lines, and polygons. These data are created by digitizing the base data. They store information in x, y coordinates.

Attribute Data: Attribute data is information appended in tabular format to spatial features.

Digital Elevation Model (DEM): Digital Elevation Model (DEM) is the digital representation of the land surface elevation with respect to any reference datum.

Map projections: A map projection is a mathematical formula used to transfer all or part of the curved surface of the earth onto the flat surface of a map.

Datum: a datum is a set of reference points on the earth's surface against which position measurements are made, and (often) an associated model of the shape of the earth (reference ellipsoid) to define a geographic coordinate system.

Some GIS software: Arc view, Map info, 21st century etc.

Basics of Remote Sensing: Remote sensing is an art and science of deriving information about the earth surface without contact of it.

Electromagnetic Radiation: *Electromagnetic radiation* is an electric and magnetic disturbance traveling through space at the speed of light (2.998 × 108 m/s).

Electromagnetic Spectrum: The electromagnetic spectrum is the range of frequencies of electromagnetic radiation and their respective wavelengths.

Satellite: A satellite is an object that has been intentionally placed into orbit.

Digital Image Processing: *Digital Image Processing* (DIP) is a technique which involves manipulation (editing, rectifying, transforming etc.) of *digital image* to extract information.

Sub Unit – 3: Measure of Central Tendency

Central Tendency

Raw statistical data can be condensed to a large extent by the methods of classification and tabulation. But this is not enough as have to depend on some mathematical measures for studying this data. One of the most important objectives of statistical analysis is to get one single value that describes the characteristics of the entire data.

Mathematical Averages

Mathematical averages are generally calculated by summing up a group of values and dividing it by the number of values.

They are categorised into

1. Arithmetic Mean
2. Geometric Mean
3. Harmonic Mean

Positional Average

Positional averages are those averages whose values are determined according to their relative position in a given set of data. They include median and mode.

Dispersion

A measure of dispersion may be defined as statistics signifying the extent of the scatteredness of items around a measure of central tendency. A measure of dispersion may be expressed in an 'absolute form' or in 'relative form'. It is said to be in an absolute form when it states the actual amount by it which the value of an item on an average deviate from a measure of central tendency. Absolute measures are expressed in concrete units. $e.g.$ Rupees, kilogram etc.

Standard Deviation (SD)

The mean deviation ignores the $'+'$ and $'-'$ signs in the data. If the signs are also taken into account, the deviations are squared and added together. When this value is divided by number of observations, it gives the variance (σ^2). The square root of variance is standard deviation (σ). The standard deviation measures the absolute dispersion or variability of the distribution. The greater the amount of dispersion, the greater is the standard deviation.

Correlation

Correlation analysis can be referred as the statistical tool used to describe the degree to which one variable is related to another. Correlation is a statistical tool that helps to measure and analyse the degree or extent to which two or more variable fluctuate with reference to one another. For correlating two phenomenon, it is essential that the two phenomenon should have a cause effect relationship and if such relationship does not exist then the two phenomenon cannot to be correlated.

Regression Analysis

This technique is used to determine the statistical relationship between two or more variables and to make prediction of one variable on the basis of one or more other variables. In regression analysis, there are two types of variables, the dependent variable is known as *regressed* (or explained) and independent variable is known as *regresser* (or predictor or explanatory) variable.

Hypothesis of Testing

A hypothesis is an approximate assumption that a researcher wants to test for its logical or empirical consequences. Hypothesis is regarded as a convenient mathematical approach for simplifying cumbersome calculation. Setting up and testing hypothesis is an integral art of statistical inference.

Sampling

Sampling is a technique, which helps us in understanding the parameters or characteristics of the universe or population by examining only a small part of it. It is necessary to take a representative sample from the population, since it is extremely costly, time consuming and cumbersome to be a complete census. If the sample is truly representative of the population, then characteristics of the sample can be considered to be the same as those of the entire population. The part of population which is chosen to study and make the inference is known as the *sample.* e.g. a small amount of blood sample taken from a patient can determine whether the patient's sugar level is normal or not. This is so because the small sample of blood is truly representative of the entire blood in the body.

Sub Unit – 4: Morphometric Analysis

Morphometry of Drainage Basins:
In geomorphology, morphometry is defined as measurement and mathematical analysis of configuration of Earth's surface and the shape and dimensions of its landforms. It includes quantitative study of the area, its volume, altitude, slope, profiles and drainage basin characteristics of the concerned area. It has two distinct branches.

Stream Order:
Stream order refers to the hierarchial position of a stream within a drainage basin. Stream ordering is studied as different branches of a stream have different characteristics. Gravelius first determined the order of stream network in 1914. He identified the main stream by tracing its source to the outlet. It was identified on the basis of greatest width, discharge, branching etc. and it was designated as 1st order stream. All of the steams joining the 1st order main stream were designated as 2nd order streams. All the streams joining the 2nd order streams were termed as 3rd order and it continued till the most remote tributaries were identified and assigned the highest order. Since, it was based on subjective decision of the investigator, so it was not appreciated.

Bifurcation Ratio:
The bifurcation ratio determines the branching pattern of drainage network. It is defined as the ratio, of number of streams of a given order (N_μ) to the number of streams of the net higher order $(N_\mu + 1)$

$$R_b = \frac{N_\mu}{N_\mu + 1}$$

Relief Morphometry:
The difference in altitude between the highest and lowest point in a given area is defined as relief. It describes the elevation of surface from the surrounding land. Relief is also the measure of energy head from which potential energy can be obtained. The valley forms, their variation with respect to space and time are influenced by relative relief.

Hypsometric Analysis:
Hypsometry involves the measurement and analysis of relationship between altitude and basin area. It helps in understanding the degree of dissection and stages of cycle of erosion. Area-height curves, hypsometric curves and percentage hypsometric curves are generally used to show the relationships between altitudes and area of the basin.

Slope Analysis:

Angular inclinations of terrain between hill tops and valley bottom is referred to as slope. It is a combinaiton of several factors like geological structure, ahsolute and relative reliefs, climare, vegetation cover, drainage texture and frequency, dissection index etc.

Section – 2: Key Statements

Basic key Statements:

Maps(9.1.2), Scale(9.1.2.1.1), General-purpose map(9.1.2.2), Topographical Map(9.1.2.2), thematic map(9.1.2.2), Qualitative maps(9.1.2.2), Quantitative maps(9.1.2.2), Choropleth map(9.1.3.1), Isopleth map(9.1.3.2), Chorochromatic map(9.1.3.5), Choroschematic map(9.1.3.6), Dot Maps(9.1.3.7), Flow Maps(9.1.3.8), Pie diagrams(9.1.4.1), Bar diagrams(9.1.4.2), Line Graph(9.1.4.3), Raster Data(9.2.1), Vector Data(9.2.1), Attribute Data(9.2.1), DEM(9.2.3), Co-ordinate system(9.2.4.1), Map projections(9.2.4.2), Thematic cartography(9.2.5.1), Remote Sensing(9.2.6), Sensors(9.2.6.3), Platforms(9.2.6.4), Geostationary satellite(9.2.6.4), Polar orbital satellite(9.2.6.4), IFOV(9.2.6.4), Swath(9.2.6.4), Revisit(9.2.6.4), Resolution(9.2.6.5), Central Tendency (9.3.0), Central Value (9.3.0), Arithmetic Mean (9.3.0), Median (9.3.0), Mode (9.3.0)

Standerd key Statements:

Spatial data(9.1.1.1), Non-spatial data(9.1.1.2), Small scale map(9.1.2.2), Medium scale map(9.1.2.2), Large scale map(9.1.2.2), Georeferencing(9.2.4), Datum(9.2.4.3), Spatial decision support system(9.2.5.2), Electromagnetic Radiation(9.2.6.1), Electromagnetic Spectrum(9.2.6.2), Photogrammetry(9.2.7.1), DIP(9.2.8), GPS(9.2.9), Frequency

Distribution (9.3.1), Grouped Data (9.3.1), Time Series Analysis (9.3.8), Sampling (9.3.9)

Advance key Statements:

Isarithmic map(9.1.3.3), Dasymetric map(9.1.3.4), Spatial Resolution(9.2.6.6), Spectral Resolution(9.2.6.6), Temporal resolution(9.2.6.6), Radiometric Resolution(9.2.6.6), Positional Average (9.3.2), Dispersion (9.3.3), Quartile Deviation (9.3.3), Mean Deviation (9.3.3), Standerd Deviation (9.3.3), Lorenge Curve (9.3.3), Correlation (9.3.3), Regression (9.3.5), Hypothesis Testing (9.3.6), Two Tailed and One Tailed Test (9.3.6.2), Chi-square Test (9.3.6.2)

[N.B. – Values in parenthesis are the reference number]

Section – 3: Key Facts and Figures

Sub Unit – 1:

Maps and Cartogharphy

.....

Cartography is the study and practice of making maps. Combining science, aesthetics, and technique, cartography builds on the premise that reality can be modeled in ways that communicate spatial information effectively.

9.1.1 Sources of Geographic Information and Data:

Data are simply facts or figures — bits of information, but not information itself. When data are processed, interpreted, organized, structured or presented so as to make them meaningful or useful, they are called information. Information provides context for data. The most common general sources for geographical data are: hard copy maps, aerial photographs, remotely-sensed imagery, point data, samples from surveys, existing digital data files, existing hard copy maps etc.

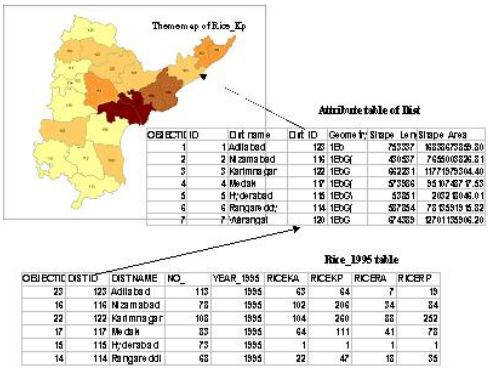
9.1.1.1 Spatial data:

Spatial data refers space related data. It refers to shape, size and location of the earth or a part of the earth, such as any administrative boundaries, road and railways, cities of towns of a country, state or district etc.

9.1.1.2 Non-spatial data:

Non- spatial data refers to other attributes associated with the feature (spatial data) such as name, length, area, volume, population, soil type, etc.

LINKING SPATIAL AND ATTRIBUTE DATA



9.1.2 Types of Maps:

A map is a symbolic depiction emphasizing relationships between elements of some space, such as objects, regions, or themes.

9.1.2.1 Essential characters of a map:

Making Date	When the map was made
Orientation	Directions (north arrow)
Grid	Locates places on the map
Scale	what the map distance is
Title	What, where, and when
Author/agency	Who is/are made the map
Legend/Index	what the symbols mean

9.1.2.1.1 Scale its essentialities:

Scale is a ratio between map distance and ground distance

How can we express scales:

$$\text{Area reduction} - \text{enlargement magnitude} = \left(\frac{\text{distane between two points on reproduced map}}{\text{distane between two points on original map}}\right)^2$$

9.1.2.2 Classification of maps:

B) According to purpose :

3. **the 'general-purpose' (or 'reference') map:**
   Those are - Political maps, Physical maps, Statistical /Distribution maps, Topographic maps, Geological maps, Geomorphological maps, Town plan maps, Cadastral maps, Weather maps, Bathymetric maps /Navigational maps, Aeronautical maps etc.

About Topographical Map:

Toposheet type	R.F.	Index i.e.
Four degree Sheet	1:1,000,000	53
Degree Sheet	1:250, 000	53A
Half Degree Sheet	1:100,000	53A NE
Quarter Degree Sheet	1:50,000	53 A/5

4. **the 'special-purpose' (or 'thematic') map**
   it may be divided into two types
   c) **Qualitative maps:**
      Region Map, Path Map, Facility Map, Resource Map etc.

   d) **Quantitative maps:**
      Data attributes are displayed on the map.

B) According to scale:

4. **Small scale map:** small-scale maps are drawn to show large areas. For example, atlas maps, wall maps, etc. (as per NATMO it starts from 1:1,000,000).
5. **Medium scale map:** It is from 1: 50,000 to 1:1,000,000
6. **Large scale map:** Large scale maps are drawn to show small areas at a relatively large-scale. For example topographical maps, cadastral map etc. it is up to 1:50,000.

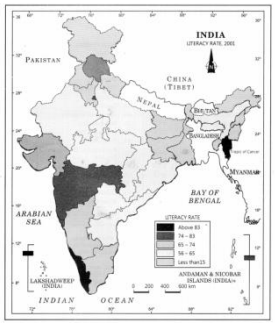
C) According to function:

3. **Physical maps:** relief, geological, climatic maps etc.
4. **Cultural maps:** political population maps etc

9.1.3 Techniques of Map Making:

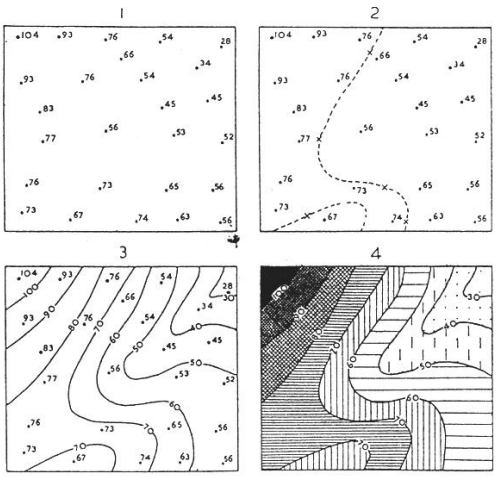
9.1.3.1 Choropleth:

A choropleth map is a type of thematic map in which areas are shaded or patterned in proportion to a statistical variable that represents an aggregate summary of a geographic characteristic within each area, such as population density or per-capita income.



9.1.3.2 Isopleth:

The word Isopleth is derived from Iso meaning equal and pleth means lines. Thus, an imaginary line, which joins the places of equal values, is referred as Isopleth. The more frequently drawn isopleths include Isotherm (equal temperature), Isobar (equal pressure), Isohyets (equal rainfall),Isonephs (equal cloudiness), Isohels (equal sunshine), contours (equal heights),Isobaths (equal depths), Isohaline (equal salinity),Contour (equal height) etc.

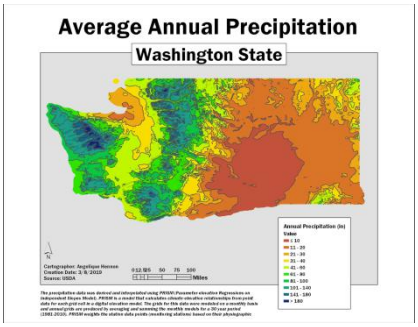


Gradient and Slope Calculation:

Gradient is as like 5 meter height reduces in 1 kilometer. So we write it as like 5meter/Kilometer. Slope is always calculated as in degree (e.g. 5°).

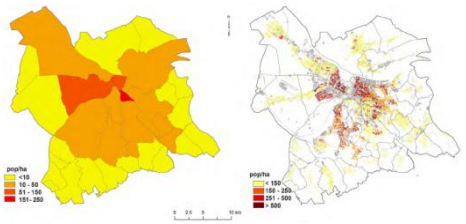
9.1.3.3 Isarithmic:

Isarithmic maps, also known as contour maps or isoline maps depict smooth continuous phenomena such as precipitation or elevation. Each line-bounded area on this type of map represents a region with the same value. For example, on an elevation map, each elevation line indicates an area at the listed elevation. An isarithmic map is a planimetric graphic representation of a 3-D surface. Isarithmic mapping requires 3-D thinking for surfaces that vary spatially.



9.1.3.4 Dasymetric:

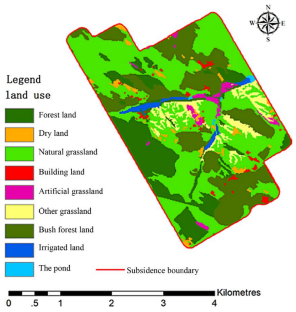
The dasymetric map is a type of thematic map that uses areal symbols to visualize a geographic field by refining a choropleth map with ancilliary information about the distribution of the variable.



Choropleth map vs Dasymetric map

9.1.3.5 Chorochromatic:

A Chorochromatic map, also known as an area-class or qualitative area maps, is a type of thematic map that portray regions of categorical or nominal data using variations in color symbols.



9.1.3.6 Choroschematic Maps:

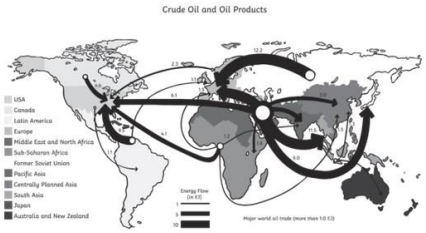
Various cartographic symbols like dots, circles, triangles, initial letters of the elements to represent on the map. This method mostly stresses on the location rather than the characteristics of the phenomenon. Neither the shape nor the color of the symbol used represents the dimension of the object. The main advantage of this method is that many elements may be shown together on a single map.

9.1.3.7 Dot Maps:

The dot maps are drawn to show the distribution of phenomena such as population, cattle, types of crops, etc. The dots of same size as per the chosen scale are marked over the given administrative units to highlight the patterns of distributions.

9.1.3.7 Flow Maps:

In cartography, **flow maps** are a mix of maps and flow charts, that "show the movement of objects from one location to another, such as the number of people in a migration, the amount of goods being traded, or the number of packets in a network.



9.1.4 Data Representation on Maps:

9.1.4.1 Pie diagrams:

A pie chart is a circular statistical graphic, which is divided into slices to illustrate numerical proportion. In a pie chart, the arc length of each slice is proportional to the quantity it represents.

9.1.4.2 Bar diagrams:

A bar chart or bar graph is a chart or graph that presents categorical data with rectangular bars with heights or lengths proportional to the values that they represent.

Types of bar:

1. Simple bar diagram
2. Multiple bar diagram
3. Compound bar diagram

9.1.4.3 Line Graph:

A line chart or line plot or line graph or curve chart is a type of chart which displays information as a series of data points called 'markers' connected by straight line segments. It is a basic type of chart common in many fields.

Several other diagrams are: Square Diagram, Circle Diagram, Sphere Diagram, Scatter Diagram, Ergograph (An ergograph is a graph that shows a relation between human activities, or agricultural/climate factors, and a seasonal year.), Wind rose etc.

Previous Year Question

Paper-II, July – 18

1. Match the **List - I** with **List - II** and select the correct answer from the code given below:

List - I (Map Type)	**List - II (Information Content)**
(a) Chorochromatic	(i) showing regional variation in distribution by shades
(b) Choroschematic	(ii) areal distribution by Tints
(c) Choropleth	(iii) showing imaginary lines joining places of equal value
(d) Isopleth	(iv) areal distribution by symbols

Code:	**(a)**	**(b)**	**(c)**	**(d)**
(1)	(i)	(iv)	(ii)	(iii)
(2)	(iv)	(i)	(iii)	(ii)
(3)	(ii)	(iv)	(i)	(iii)
(4)	(iv)	(ii)	(iii)	(i)

2. On a topographical map of 1 : 50,000 scale the contour Interval is given as 10 meters. Place 'A' is situated on a contour of 200 m MSL and another place 'B' is located on a

countour of 240 m MSL. The distance between 'A' and 'B' on the map is 4.0 cms. The correct gradiant between 'A' and 'B' therefore would be:
(1) 1/30
(2) 1/40
(3) 1/50
(4) 1/60

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	52	2	9.1.3
2.	92	3	9.1.2.1.1

Paper-II, January – 17

1. Given below are two statements, one labelled as Assertion (A) and other labelled as Reason (R). Select your answer from the codes given below:

Assertion (A): Maps that are usually referring various attributes' information are called complex Thematic maps.

Reason (R): Complex Thematic Maps are used to show locations of earth's different features and activities.

Codes:

(1) Both (A) and (R) are true and (R) is the correct explanation of (A).

(2) Both (A) and (R) are true, but (R) is not the correct explanation of (A).

(3) (A) is true, but (R) is false.

(4) (A) is false, but (R) is true.

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	48	2	9.1.1,9.1.2.1

Paper-III, January – 17

1. Which one of the following linear length measures could be derived from the fractional measure of 10–6 metres?
(1) Nanometre
(2) Micrometre
(3) Millimetre
(4) Femtometre

2. Which of the following is a non-quantitative areal distribution map?
(1) Choropleth
(2) Isopleth
(3) Multiple dots
(4) Choroschematic

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	69	2	9.2.6.2
2.	72	4	9.1.3

Paper-II, November – 17

1. Match **List-I** with the **List-II** and select the correct answer from the code given below:

List - I (Maps and Diagrams)	**List - II (Aspect)**
(a) Isopleth maps	(i) Natural grouping
(b) Dot maps	(ii) Population distribution
(c) Scatter diagram	(iii) Wind direction
(d) Star diagram	(iv) Changes over space which are relatively gradual

Code:	**(a)**	**(b)**	**(c)**	**(d)**
(1)	(iv)	(ii)	(i)	(iii)
(2)	(iv)	(i)	(iii)	(ii)
(3)	(i)	(ii)	(iii)	(iv)
(4)	(ii)	(iii)	(iv)	(i)

2. Consider the following line symbols:

(a) Isobars
(b) Contours
(c) Hachures
(d) Isochrones

Which of the above depicts relief?

Select the correct answer using the code given below:

(1) (a) and (d)
(2) (a) and (b)
(3) (b) and (c)
(4) (b) and (d)

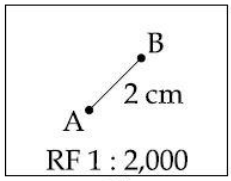
Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	47	1	9.1.3
2.	49	3	9.1.3.2

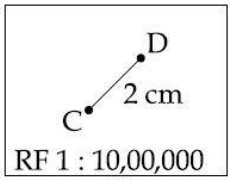
Paper-III, November – 17

1. Which one of the following phenomenal relationships is depicted by an ergograph?
(1) Temperature and absolute humidity
(2) Rainfall and runoff
(3) Crop production and rainfall
(4) Crop season and weather conditions

2. Consider the following figures X and Y:



X



Y

Which one of the following statements is correct?
(1) Figure X is small-scale map and distance between A and B is 40 metres.
(2) Figure Y is large scale map and distance between C and D is 4 km.
(3) Figure X is large scale map and figure Y is small-scale and distance between A and B and C and D are 40 metres and 20 km, respectively.
(4) Figure X is large scale and figure Y is small-scale. The ground distance between A and B, and C and D are equal.

3. Given below are two statements, one labelled as **Assertion (A)** and the other labelled as **Reason (R).** Select your answer from the code given below:
Assertion (A): Dot map is especially useful when the values are distributed unevenly and sporadically.
Reason (R): Smaller the statistical unit, more accurate is the Dot map.

Code:
(1) Both (A) and (R) are true and (R) is the correct explanation of (A).
(2) Both (A) and (R) are true, but (R) is not a correct explanation of (A).
(3) (A) is true, but (R) is false.
(4) (A) is false, but (R) is true.

Answer with Reference

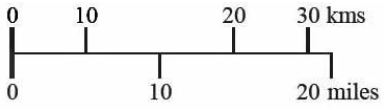
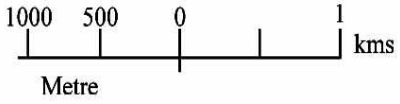
SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	68	4	9.1.4.3

2.	74	3	9.1.2.1.1
3.	75	2	9.1.3.7

Paper-III, July – 16

1. Which one of the following diagrams can be used to represent non-spatial attribute data?
(1) Flow line
(2) Bars and Cubes
(3) Choropleth
(4) Isoline

2. Match List – I with List – II and select the correct answer using the codes given below:

List – I (Types of scale)	**List – II (Scale on map)**
I. Statement	A. 1 : 25,000
II. Simple linear	B. 1 inch to 1 mile
III. Representative fraction	C. 
IV. Comparative scale	D. 

Codes:	**(I)**	**(II)**	**(III)**	**(IV)**
(1)	B	D	C	A
(2)	A	B	C	D
(3)	D	A	B	C
(4)	B	D	A	C

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	70	2	9.1.1.1, 9.1.4.2
2.	74	4	9.1.2.1.1

Paper-II, July – 16

1. Match **List – I** with **List – II** and select the correct answer using the codes given below:

List – I (R.F.)	**List – II (Level of Scale)**
I. 1 : 2,50,000	A. Cadastral
II. 1 : 50,00,000	B. Large
III. 1 : 25,000	C. Medium
IV. 1 : 4,000	D. Small

Codes:	(I)	(II)	(III)	(IV)
(1)	C	D	A	B
(2)	C	A	B	D

(3) A B C D
(4) C D B A

2. Which one of the following areal extent is represented by an area bounded by a square of 3 cm × 3 cm on a 1 : 50,000 scale topographical sheet ?
(1) 9.00 km2
(2) 1.00 km2
(3) 3.20 km2
(4) 2.25 km2

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	46	4	9.1.2.2 B
2.	47	4	9.1.2.1.1

Paper-II, Jun – 15

1. Which one of the following cartographic techniques is suitable for measuring spatial association among different attributes of the regional economy?
   (1) Bar diagram
   (2) Pie diagram
   (3) Choropleth
   (4) Isopleth

2. Match **List-I** with **List-II** and select the correct answer from the codes given below:

List-I (Method)	**List-II (uses)**
(a) Isopleth	(i) Natural groupings
(b) Dot maps	(ii) Distribution of population
(c) Scatter diagrams	(iii) Wind direction
(d) Star diagrams	(iv) Changes which are relatively gradual

Codes:	**(a)**	**(b)**	**(c)**	**(d)**
(1)	(iv)	(ii)	(iii)	(i)
(2)	(ii)	(iv)	(iii)	(i)

(3) (iv) (ii) (i) (iii)
(4) (ii) (iv) (i) (iii)

3. Which one of the following is shown with the help of Isobaths?
(1) Salinity of sea Water
(2) Depth of Ocean water
(3) Altitude of Oceanic ridge
(4) Amplitude of wave

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	48	1	9.1.4.2
2.	49	3	9.1.3.2, 9.1.3.7, 9.1.4.3
3.	50	2	9.1.3.2

Paper-III, Decamber – 15

1. Which one of the following data can be represented by means of Choropleth map?
(1) Location Specific
(2) Point Specific
(3) Area specific
(4) Line Specific

2. Match **List-I** with **List – II** and select the correct answer from the codes given below:

List List – I (Aspect)	**List – II (Diagram)**
(a) Rural and Urban Population	(i) Comparative Bars
(b) population density	(ii) Isolines
(c) Relative relief	(iii) Dots and Spheres
(d) Decadal Population	(iv) Choropleth

Codes:	**(a)**	**(b)**	**(c)**	**(d)**
(1)	(iv)	(iii)	(i)	(ii)
(2)	(i)	(ii)	(iii)	(iv)
(3)	(ii)	(i)	(iv)	(iii)
(4)	(iii)	(iv)	(ii)	(i)

3. Which of the following diagrams are called Pie-diagrams?
(1) Pictorial diagrams
(2) Circle and sector diagrams
(3) Ring diagrams
(4) Sphere diagrams

4. Match **List-I** with **List – II** and select the correct answer from codes given below:

List – I (Linear lengths)	**List – II (Fractional measures)**
(a) Nanometre	(i) 10^{-6}
(b) Micrometre	(ii) 10°
(c) MIllimetre	(iii) 10^{-9}
(d) Metre	(iv) 10^{-3}

Codes:	**(a)**	**(b)**	**(c)**	**(d)**
(1)	(iv)	(iii)	(ii)	(i)
(2)	(iii)	(iv)	(i)	(ii)
(3)	(iii)	(i)	(iv)	(ii)
(4)	(i)	(iii)	(ii)	(iv)

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	67	3	9.1.3.2
2.	68	4	9.1.3.1, 9.1.3.7, 9.1.3.2
3.	69	2	9.1.4.1
4.	73	3	9.2.6.2

Paper-II, Jun – 14

1. Flow maps are used to show the distribution of which type of following data?
(1) Line
(2) Area
(3) Point
(4) Volume

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	49	C	9.1.3.7

Paper-III, June – 14

1. Which of the following diagrams is used to show proportion of different land uses in an area?
(1) Pie
(2) Wind rose
(3) Line
(4) Flow-Chart

2. The contour interval followed in SOI Toposheet with 1/50,000 scale is:
(1) 20 Metres
(2) 50 Metres
(3) 100 Metres
(4) 150 Metres

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	63	1	9.1.4.1
2.	65	1	9.1.2.2A

PAPER-II

Decamber – 14

1. Which one of the following diagrams is most suitable for depicting the distribution of urban land-use types of spatially spread urban centres?
   (1) Histogram
   (2) Sphere
   (3) Bar
   (4) Pie

2. A map with the scale of 1/50,000 is enlarged to 5-times, which one of the following scales is correct for the enlarged map?
   (1) 1/250,000
   (2) 1/100,000
   (3) 1/10,000
   (4) 1/2,500

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.

1.	49	4	9.1.4.1
2.	50	3	9.1.2.1.1

Paper-III, Decamber – 14

1. Which of the following thematic maps is combined with complex themes?
Select the correct combination of complex-thematic map from the codes given below:
A. Soil spread

B. Forest cover
C. Crop combination
D. Rainfall potential

Codes:

(1) 1 and 2
(2) 2 and 3
(3) 3 and 4
(4) 2 and 4

2. Which one of the following number of Parallels with one degree interval can be drawn between the poles on a globe?

(1) 180
(2) 178
(3) 179
(4) 181

3. Which one of the following symbols does not represent a point data?

(1) Spot heights
(2) Bench marks
(3) Contours
(4) Triangulation stations

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	68	4	9.1.3
2.	69	3	9.2.4.2
3.	70	3	9.1.3.2

Sub Unit – 2:

GIS and Remote Sensing

……

A geographic information system is a conceptualized framework that provides the ability to capture and analyze spatial and geographic data.

9.2.1 GIS Database:

Raster Data:

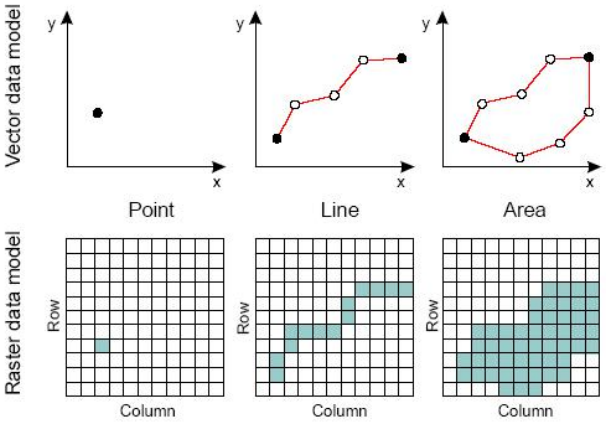
A raster data structure is based on a tessellation of the 2D plane into cells.

Vector Data:

It is the representation of the points, lines, and polygons. These data are created by digitizing the base data. They store information in x, y coordinates.

Attribute Data:

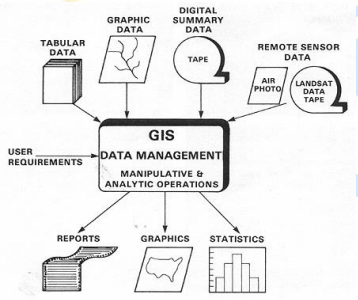
Attribute data is information appended in tabular format to spatial features. The spatial data is the where and attribute data can contain information about the what, where, and why. Attribute data provides characteristics about spatial data.



9.2.2 Functions of GIS:

Steps:

1. Data capture
2. Data compilation
3. Data storage (GIS data Model)
4. Manipulation
5. Analysis



9.2.3 Digital Elevation Model (DEM):

Digital Elevation Model (DEM) is the digital representation of the land surface elevation with respect to any reference datum.

9.2.4 Georeferencing:

Georeferencing is the process of taking a digital image, it could be an airphoto, a scanned geologic map, or a picture of a topographic map, and adding geographic information to the image so that GIS or mapping software can 'place' the image in its appropriate real world location.

Steps of georeferenceing:

1. Add the raster dataset that aligns with the projected data.
2. Add control points that link known raster dataset positions to known positions in map

coordinates, map projection and datum.

3. Save the **georeferencing** information when the registration is satisfactory.

9.2.4.1 Co-ordinate system:

A geographic coordinate system (GCS) uses a three-dimensional spherical surface to define locations on the earth. ... A point is referenced by its longitude and latitude values.

9.2.4.2 Map projections:

A map projection is a mathematical formula used to transfer all or part of the curved surface of the earth onto the flat surface of a map.

9.2.4.3 Datum:

a datum is a set of reference points on the earth's surface against which position measurements are made, and (often) an associated model of the shape of the earth (reference ellipsoid) to define a geographic coordinate system.

9.2.5 GIS Applications:

The major applications of GIS is-

9.2.5.1 Thematic cartography:

Thematic map making is the first and major application in GIS.

9.2.5.2 Spatial decision support system:

A spatial decision support system is an interactive, computer-based system designed to assist in decision making while solving a semi-structured spatial problem. It is designed to assist the spatial planner with guidance in making land use decisions.

Some GIS software: Arc view, Map info, 21st century etc.

9.2.6 Basics of Remote Sensing:

Remote sensing is an art and science of deriving information about the earth surface without contact of it.

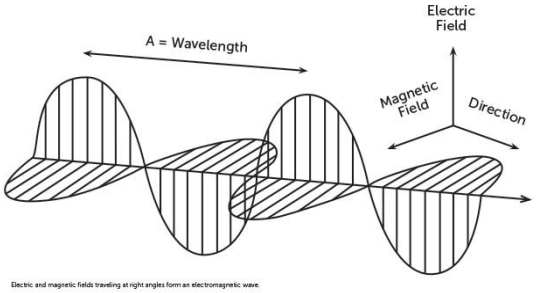
Components:

There are four basic components of a remote sensing system

(1) a target
(2) an energy source
(3) a transmission path
(4) a satellite sensor

9.2.6.1 Electromagnetic Radiation:

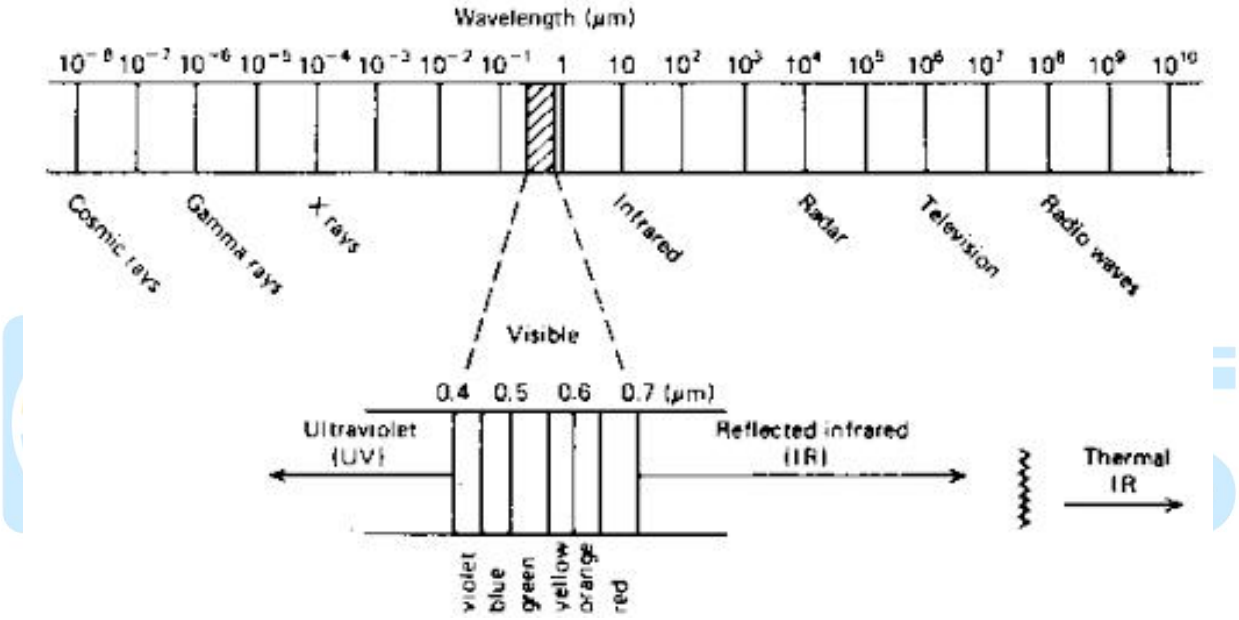
Electromagnetic radiation is an electric and magnetic disturbance traveling through space at the speed of light (2.998 × 108 m/s).



Electric and magnetic fields traveling at right angles form an electromagnetic wave.

9.2.6.2 Electromagnetic Spectrum:

The electromagnetic spectrum is the range of frequencies of electromagnetic radiation and their respective wavelengths. 1μm=10^{-6}meter



9.2.6.3 Sensors:

There are two types of sensors –

1. Active Sensors (LiDAR, radar, GPS, x-ray, sonar, infrared and seismic sensors)
2. Passive Sensors (film photography, infrared, charge-coupled devices, and radiometers etc.)

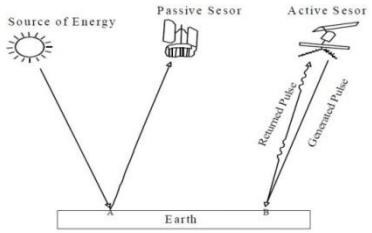


Fig 2.2 active and passive sensor

9.2.6.4 Platforms:

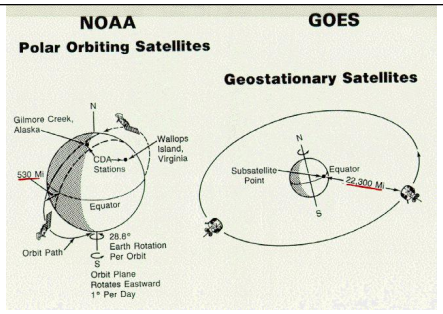
There are two types of platforms used for remote sensing-

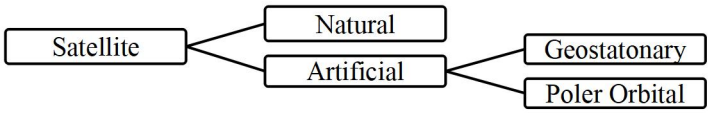
1. Air borne platform
2. Space born platform

Except those the ground born platform is relatively less in use.

Satellite:

A satellite is an object that has been intentionally placed into orbit. These are two types-

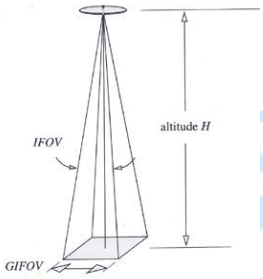




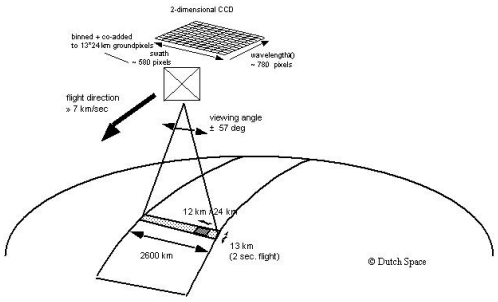
IFOV: IFOV (Instantaneous Field of View) A measure of the spatial resolution of a remote sensing imaging system.

Swath: The area imaged on the surface, is referred to as the swath.

Revisit: It is the time elapsed between observations of the same point on earth by a satellite.



IFOV



Swath

9.2.6.5 Resolution:

Resolution refers to the number of pixels in an image. Resolution is sometimes identified by the width and height of the image as well as the total number of pixels in the image. For example, an image that is 2048 pixels wide and 1536 pixels high (2048 x 1536) contains (multiply) 3,145,728 pixels (or 3.1 Megapixels).

9.2.6.6 Types:

A. Spatial Resolution refers to the size of the smallest feature that can be detected by a satellite sensor or displayed in a satellite image. It is usually presented as a single value representing the length of one side of a square. For example, a spatial resolution of 250m means that one pixel represents an area 250 by 250 meters on the ground.

B. Spectral Resolution: it refers to the ability of a satellite sensor to measure specific wavelengths of the electromagnetic spectrum. The finer the spectral resolution, the narrower the wavelength ranges for a particular channel or band.

C. Temporal resolution: It refers to the time between images. The capability for satellites to provide images of the same geographical area more frequently has increased dramatically since the dawn of the space age.

D. **Radiometric Resolution:** The radiometric resolution of image data in remote sensing stands for the ability of the sensor to distinguish different grey-scale values. It

is measured in bit. The more bit an image has, the more grey-scale values can be stored, and, thus, more differences in the reflection on the land surfaces can be spotted.

Table 1. Remote sensing satellites with panchromatic and multispectral sensors

Satellite	Country (Year)	Sensors	Spatial resolution (m)	Revisit time (days)	Remark
Resourcesat-2	India (2011)	4 MS - LISS IV 4 MS - LISS III 3 MS - AWiFS	5.8 23.5 56	5 5 5	-
Resourcesat-2A	India (2017)	4 MS - LISS IV 4 MS - LISS III 3 MS - AWiFS	5.8 23.5 56	5 5 5	-
Resourcesat-3* series	India (2020-2021)	5 MS	10/20	5	
Cartosat-1	India (2005)	PAN	2.5	5	Stereo
Cartosat-2A	India (2008)	PAN	<1	4	-
Cartosat-2B	India (2010)	PAN	<1	4	
Cartosat-2 series (2C,2D,2E &2F)	India (2017 and 2018)	PAN	<1	4	
Cartosat-3A*	India (2020-21)	1 PAN 4 MS MIR VNIR & SWIR	0.25 0.50 5 30	Daily	Continu
GISAT / GeoHR	India (2020-21)	6 VNIR	50	Daily 30 minutes	
IKONOS	USA (2000)	PAN MS (4)	0.8 4	3-5 3-5	Stereo
Landsat-8	USA (2013)	OLI (8) TIRS (2) PAN	30 100 15	16	
SPOT-7	France (2014)	PAN MS (3)	2.5 10/20	1-5	Stereo
Rapid Eye	Germany (2008)	MS (5)	6.5	1-5.5	
WorldView-3	USA (2014)	PAN MS (8) MS SWIR (8)	0.3 1.2 3.7	1-4.5	-
Planet Labs	USA (2014)	PAN MS (3)	3 5	-	-
GeoEye-1	USA (2008)	PAN MS (4)	0.46 1.84	3	
Sentinel 2A & 2B	EU (2015)	MS-VNIR (4) MS-VNIR (6) MS-SWIR (3)	10 20 60	5 5 5	-
Terra - ASTER	US (1999)	MS (14) MS-IR (2)	15/30 90	4-16 4-16	
Terra - MODIS	US (1999)	MS-HIS (36)	250, 500 & 1000	Twice daily	-
Landsat-9*	US (2023)	OLI (8) TIRS (2) PAN	30 100 15	16	-
HyspIRI*	US (2020)	8 (IR)	60	5	

*Remote sensing satellites to be launched.

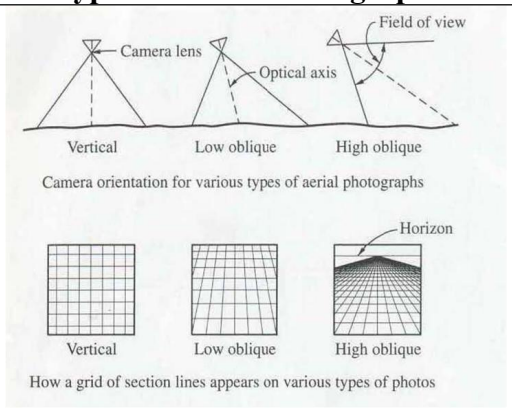
9.2.7 Elements of Air Photo and Satellite Image Interpretation:

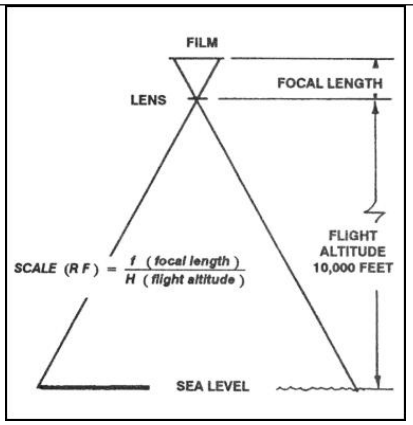
The basic elements of interpretation are shape, size, pattern, tone, texture, shadows, location, association and resolution.

9.2.7.1 Photogrammetry:

Photogrammetry is the science and technology of obtaining reliable information about physical objects and the environment through the process of recording, measuring and interpreting photographic images and patterns of electromagnetic radiant imagery and other phenomena.

9.2.7.2 Types of Aerial Photographs:



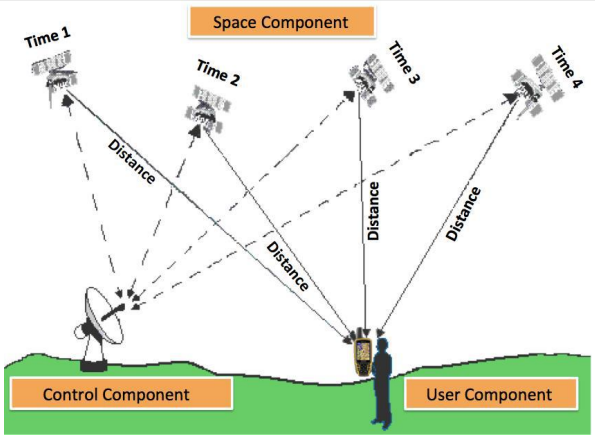


9.2.8 Digital Image Processing:

Digital Image Processing (DIP) is a technique which involves manipulation (editing, rectifying, transforming etc.) of *digital image* to extract information.

9.2.9 GPS Components:

The three main components are the GPS satellites, the GPS receivers, and the complex computer software needed to decode the signals and compute the geographical position of the user. Up to 24 GPS satellites fly, mostly in highly inclined (polar) orbits, at altitudes around 20,000 km.



9.2.9.1 GPS applications:

GPS has many applications for both the military and civilians. Civilians applications include - Navigation, astronomy, cartography, mapping, cellular telephony, disaster relief, radio occultation, clock synchronization, geotagging, geofencing, fleet tracking, air tracking, mining, tours, recreation, robotics, surveying, sports, tectonics, telematics and other uses, while in the military it has found its usefulness in the following areas: navigation, target tracking, missile and projectile guidance, search and rescue, reconnaissance, as nuclear detonation detectors.

Previous Year Question

Paper-II, July – 18

1. Which one of the following organisations looks after the receiving and processing of remote sensing data in India?
(1) SHAR Centre
(2) SDS Centre
(3) LPS Centre
(4) NRSC

2. Which one of the following is the correct sequences of various EMR spectrum bands in an ascending order of wavelength?
(1) Blue-Green-Red-Ultraviolet
(2) Red-Blue-Green-Ultraviolet
(3) Ultraviolet-Blue-Green-Red
(4) Ultraviolet-Green-Blue-Red

3. Given below are the two statements, one labelled as **Assertion (A)** and the other labelled as **Reason (R).** Select your answer from the code given below:
Assertion (A) : Radars are Considered active sensors.
Reason (R) : These sensors detect objects and their ranges using radio waves.
Code:
(1) Both (A) and (R) are true and (R) is the correct explanation of (A).
(2) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(3) (A) is true but (R) is false.
(4) (A) is false but (R) is true.

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	94	4	9.2.6.6
2.	95	3	9.2.6.1, 9.2.6.2
3.	96	1	9.2.6.3

Paper-II, January – 17

1. Given below are two statements, one labelled as **Assertion (A)** and other labelled as **Reason (R).** Select your answer from the codes given below:
Assertion (A): Remote sensing is defined as the science and art of acquiring data about earth's objects from a distance without physical contact
Reason (R): The collection of data is only conducted by means of remote sensors installed in aircraf and satellite
Codes:
(1) Both (A) and (R) are true and (R) is the correct explanation of (A)

(2) Both (A) and (R) are true, but (R) is not the correct explanation of (A)
(3) (A) is true but (R) is false.
(4) (A) is false but (R) is true.

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	50	3	9.2.6

Paper-III, January – 17

1. Match **List-I** with **List-II** and select the correct answer from the codes given below:

List-I (Land use / Land cover types)	**List-II (Conventional colour map symbols)**
I. Forests	A. Yellow
II. Cultivated areas	B. Red
III. Uncultivable land	C. Dark green
IV. Built up areas	D. Brown

Codes:	**(I)**	**(II)**	**(III)**	**(IV)**
(1)	C	A	D	B
(2)	D	C	B	A
(3)	A	D	B	C
(4)	C	A	B	D

2. Which one of the following systems uses the vector and raster data?

(1) Remote Sensing System

(2) Geographical Information System
(3) Global Positioning System
(4) Both (1) and (2)

3. Match List-I with List-II and select the correct answer from the codes given below:

List-I (EMR spectral band)	**List-II (Wavelength (Micron))**
I. Visible	A. 0.8 – 1.1
II. Ultraviolet	B. 10.0 – 12.5
III. Infrared	C. 0.3 – 0.4
IV. Thermal	D. 0.4 – 0.7

Codes:	**(I)**	**(II)**	**(III)**	**(IV)**
(1)	B	A	D	C
(2)	A	B	C	D
(3)	D	C	A	B
(4)	C	D	B	A

4. Given below are two statements, one labelled as **Assertion (A)** and the other labelled as **Reason (R).** Select your answer from the codes given below:

Assertion (A): Area sampling by random numbers requires the area under study which should be gridded within two areas at right angle.

Reason (R): The intersections of row and column of the area will give the sample locations of observation inthe area.

Codes:
(1) Both (A) and (R) are true and (R) is the correct explanation of (A).
(2) Both (A) and (R) are true, but (R) is not the correct explanation of (A).
(3) (A) is true, but (R) is false.
(4) (A) is false, but (R) is true.

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	67	4	Fundamental question
2.	68	2	9.2.1
3.	70	3	9.2.6.2
4.	75	2	Statistics

Paper-II, November – 17

1. Which one of the following is the correct sequence (in the ascending order) of EMR spectral bands?
(1) Blue - Green - Red - Ultra Violet
(2) Ultra Violet - Blue - Green – Red
(3) Ultra Violet - Red - Blue - Green
(4) Green - Red - Blue - Ultra Violet

2. Which one of the following group of colours is called primary colours?
(1) White, red and green
(2) Blue, green and red
(3) Yellow, violet and indigo
(4) Green, blue and black

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	46	2	9.2.6.1, 9.2.6.2
2.	48	2	Fundamental question

Paper-III, November – 17

1. Which one of the following sensors is an active remote sensing sensor?
(1) Photo Camera
(2) Multiframe Camera
(3) Multiband Scanner
(4) Radar

2. Consider the following statements:
(a) Tele-communication satellites are mostly Geostationary satellites usually placed at an altitudes of more than 30,000 km.
(b) Resource satellites are sun synchronous usually placed at an altitude of 300 - 1000 km. Which of the above statements are true?
(1) (a) only
(2) both (a) and (b)
(3) (b) only
(4) neither (a) nor (b)

3. Which one of the following altitudes belongs to sun synchronous polar orbit?
(1) 30,000 to 36,000 km
(2) 2,000 to 6,000 km
(3) 300 to 1000 km
(4) 5,000 to 15,000 km

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	73	4	9.2.6.3
2.	72	2	9.2.6.4
3.	69	3	9.2.6.4

Paper-III, July – 16

1. Match List – I with List – II and select the correct answer using the codes given below:

List – I (Sat. Sensors)	**List – II (IFOV-Pan)**
I. IRS-IC LISS II	A. 0.61 m
II. SPOT-5 HRV	B. 5.80 m
III. DG-Quick Bird-2	C. 8.00 m
IV. ADEOS-AVNIR	D. 5.00 m

Codes:	**(I)**	**(II)**	**(III)**	**(IV)**
(1)	D	B	C	A
(2)	B	D	A	C
(3)	A	B	C	D
(4)	B	A	D	C

2. which one of the following codes given for abbreviations correctly depicts landscape models?

(a) DEM (b) DRG
(c) DLG (d) DTM

Codes:

(1) (a) and (b)
(2) (b) and (c)
(3) (a) and (d)
(4) (c) and (d)

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	68	2	9.2.6.6
2.	75	3	9.2.3

Paper-II, July – 16

1. Which one of the following softwares is not a GIS software?
(1) AutoCAD
(2) Map Info
(3) ERDAS
(4) Arc view

2. Given below are two statements, one labelled as Assertion (A) and other labelled as Reason (R). Select your answer from the codes given below:
Assertion (A): Change detection in remote sensing is the process of identifying differences in the state of an object or phenomenon
Reason (R): The use of GIS facilitates for digital change detection
Codes:
(1) Both (A) and (R) are true and (R) is correct explanation of (A).
(2) Both (A) and (R) are true, but (R) is not correct explanation of (A).
(3) (A) is true, but (R) is false.
(4) (A) is false, but (R) is true

3. The scale on the aerial photography is variable on account of which of the following?
(1) Shadows of the objects
(2) Texture of the objects
(3) Relief of the ground
(4) Shadows and relief both

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	45	1	9.2.5
2.	48	2	9.2.1, 9.2.6
3.	50	3	9.2.7

Paper-III, Jun – 15

1. Spatial data is stored in computer by using:
(1) Plotter digitizer and keyboard
(2) Keyboard and plotter
(3) Scanner, Digitizer and keyboard
(4) Digitizer and scanner

2. LANDSAT, SPOT and IRS are examples of:
(1) Sun-synchronous satellites
(2) Geostationary satellites
(3) Radars
(4) Natural satellites

3. Which one of the following statistical method is best suited for groundwater exploration by using GIS tools?
(1) Standard deviation method
(2) Principal component analysis method
(3) Trial and error method
(4) Index-overlay method

4. Which one of the following countries first launched Operational Remote Sensing satellite?
(1) USA
(2) UK
(3) USSR
(4) Germany

5. Raster data start from:
(1) Top – Right corner of the displayed window.
(2) Top-left corner of the displayed window.
(3) Bottom-Right corner of the displayed window.
(4) Bottom-Left corner of the displayed window.

6. Match **List-I** with **List-II** and select the correct answer from the codes given below:

List – I	**List-II**

(Landsat 4 and 5 TM)	(System Characteristics)
(a) IFOV	(i) 185 km
(b) (b) Revisit	(ii) 705 km
(c) Altitude	(iii) 16 days
(d) Swath	(iv) 30×30 m for 1-5,7 bands

Codes:	(a)	(b)	(c)	(d)
(1)	(i)	(ii)	(iii)	(iv)
(2)	(ii)	(iii)	(i)	(iv)
(3)	(iv)	(iii)	(ii)	(i)
(4)	(iv)	(iii)	(i)	(ii)

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	68	4	9.2.2
2.	69	1	9.2.6.4
3.	70	4	9.2.5

4.	71	1	9.2.6.6
5.	72	2	9.2.1
6.	75	3	9.2.6.4

Paper-II, Decamber – 15

1. Among the following satellite series, which has the oldest remote sensing programme?
(1) IRS Series
(2) LANDSAT Series
(3) SPOT Series
(4) NOAA Series

2. Which one of the following Remote Sensing Sensors Penetrate vegetation cover?
(1) An optical sensor

(2) An infrared sensor
(3) A thermal sensor
(4) All types of sensor

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	49	2	9.2.6.6
2.	50	3	9.2.6.2, 9.2.6.3

Paper-III, Decamber – 15

1. Match **List-I** with **List-II** and select the correct answer from the codes given below:

List – I (Satellite)	**List – II (Altitude)**
(a) IRS – 1A	(i) 36,000 kms
(b) SPOT – 3	(ii) 705 kms
(c) LANDSAT – V	(iii) 932 kms
(d) INSAT Series	(iv) 832 kms

Codes:	**(a)**	**(b)**	**(c)**	**(d)**
(1)	(iii)	(iv)	(ii)	(i)
(2)	(iv)	(iii)	(i)	(ii)
(3)	(ii)	(i)	(iv)	(iii)
(4)	(i)	(ii)	(iii)	(iv)

2. Among the following water which will have highest spectral reflectance in visible band?
(1) Clear water
(2) Clay filled/ Suspended water
(3) Algae mixes with water

(4) Silt and Algae mixed water

3. Which of the following will happen when satellite images are geo-referenced?
(1) Contrast images are improved
(2) Positional errors are removed
(3) Errors in DN values are removed
(4) None of the above

4. Match **List-I** with **List-II** and select the correct answer from the codes given below:

List – I (Bands of Energy)	**List –II (Wavelength in)**
(a) Photographic	(i) 3.0 – 15.0
(b) Optical	(ii) 0.7 – 0.3
(c) Reflected Infrared	(iii) 0.3 – 15.0
(d) Far Infrared	(iv) 0.3 – 0.9

Codes:	**(a)**	**(b)**	**(c)**	**(d)**
(1)	(iv)	(iii)	(ii)	(i)
(2)	(i)	(ii)	(iii)	(iv)
(3)	(iii)	(i)	(iv)	(ii)
(4)	(ii)	(iv)	(i)	(iii)

Answer with reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	70	1	9.2.6.4
2.	71	2	9.2.6.2
3.	72	2	9.2.6
4.	75	1	9.2.6.2

Paper-II, Jun – 14

1. Match List – I with List – II and select the correct answer from the codes given below:

List-I (Spectral Bands)	**List-II (Wavelength)**
a. Visible region	i. 8-12 micrometre
b. Near Infrared	ii. 1 mm-1.0 metre
c. Microwave	iii. 0.7- 3.0 micrometre
d. Thermal Infrared	iv. 0.4- 0.7 micrometre

Codes:	**(a)**	**(b)**	**(c)**	**(d)**
(1)	iv	ii	iii	i
(2)	iii	iv	i	ii
(3)	iv	iii	ii	i
(4)	iii	iv	ii	i

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	48	3	9.2.6.2

Paper-III, Jun – 14

1. Which of the following is a GIS operation?
(1) Image displaying
(2) Contrast stretching
(3) Map over laying
(4) Map designing

Answer with Geography

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	62	2	9.2.

Paper-II, Decamber – 14

1. Match **List – I** with **List – II** and select the correct answer using the codes given below:

List – I (Satellites)	**List – II (Countries)**
i. IRS	a. India
ii. SPOT	b. Europe
iii. ENVI SAT	c. U.S.A.
iv. IKONOS	d. France

Codes:	**(a)**	**(b)**	**(c)**	**(d)**
(1)	i	iv	iii	ii
(2)	i	iii	iv	ii
(3)	ii	i	iii	iv
(4)	iv	iii	i	ii

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	48	2	9.2.6.6

Paper-III, December – 14

1. The image of which satellite data product is used as substitute of cadastral map.
(1) Landstat TM
(2) SPOT Xs
(3) INSAT 1B
(4) IKONOS

2. Which one of the following Digital numbers is correctly matched with its byte value?
Bytes Digital Value
(1) 6 – 128
(2) 8 – 512
(3) 7 – 256
(4) 5 – 32

3. Which one of the following locations is correct with reference to Ground control points?
(1) Satellite control station
(2) Co-ordinates of places i.e., latitudes and longitudes.
(3) Places with established co-ordinates and height above MSL
(4) Height of places above MSL

4. Which one of the following is not an outcome of GIS modelling?
(1) Binary model
(2) Index model
(3) Regression model
(4) Iconic model

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	71	4	9.2.6.6
2.	72	3	9.2.6.6 D
3.	73	2	9.2.9
4.	74	4	9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.2.5

Sub Unit – 3:

Measures of central Tendency

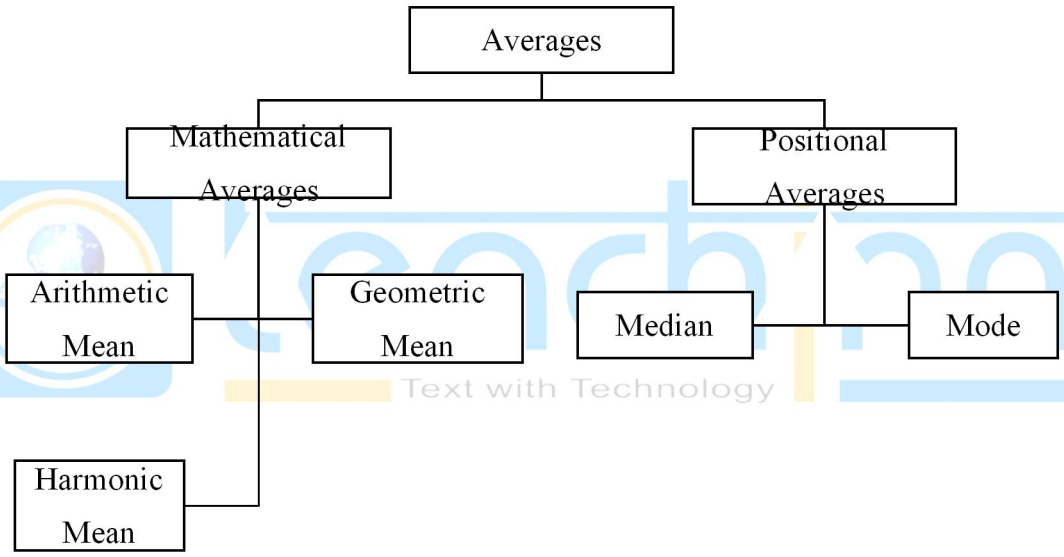
……

9.3.0 Central Tendency

Raw statistical data can be condensed to a large extent by the methods of classification and tabulation. But this is not enough as have to depend on some mathematical measures for studying this data. One of the most important objectives of statistical analysis is to get one single value that describes the characteristics of the entire data.

This value is called the *central value or average.* This value is the point around which all other values of the data are clustered. Therefore, it is known as measure of location and since this value is located at a central point nearest to other values of the data, it is known as measure of central tendency. The measure of central tendency can be of many types but the most common are mean or average, median and mode.

Averages are broadly classified into mathematical and positional average. The mathematical average includes geometric, arithmetic and harmonic mean whereas positional averages include mode and median.



9.3.1 Mathematical Averages

Mathematical averages are generally calculated by summing up a group of values and dividing it by the number of values.

They are categorised into

4. Arithmetic Mean
5. Geometric Mean
6. Harmonic Mean

Arithmetic Mean

i. **Arithmetic Mean of Ungrouped Data.** The arithmetic mean is the most simple and frequently used average.

This is the sum of the values divided by their total number i.e. we obtain its value by adding together the sizes of all the items and dividing this total by the number of items. Arithmetic mean is represents by the symbol $\overline{X}$.

$$\overline{X} = \frac{x_1 + x_2 + x_3 + \ldots + x_n}{n}$$

$$\overline{X} = \frac{\sum x}{n}$$

Where, $\overline{X}$ is the arithmetic mean

$\sum x$ is the sum of the values of the variables n is the total number of observations

ii. **Arithmetic Mean of a Frequency Distribution** A frequency distribution consists of data that are grouped into classes. Every observation (value) is placed in one of the classes.

Formula of arithmetic mean of a frequency distribution is-

$$\overline{X} = \frac{\sum (f \times x)}{n}$$

Where, $\sum$ = Notation for sum

f = Number of observations in each class

x = Class mark or mid-point of each class

n = Number of observations in the sample

iii. **Arithmetic Mean of a Grouped Data** To compute the arithmetic mean of grouped data, mid-point of each class is calculated and multiplied by frequency of observations in the corresponding class. Then all these results are added and sum is divided by the number of observations.

9.3.2 Positional Average

Positional averages are those averages whose values are determined according to their relative position in a given set of data. They include median and mode.

Median

Median is measure of central tendency. If a series of value is arranged either in ascending or in descending order of magnitude then the middle term or the mean of the two middle terms according to the number of values (odd or even) is called the median. This measure divides the series into two equal parts. Thus, the median is the size of the middle most item, if the items are arranged in ascending or descending order of magnitudes.

Calculation of Median from Ungrouped Data

Illustration Find the median of

80,70,30,29,82,86,75,69,79, and 38.

Solution: First arranged the data in ascending order

29,30,38,69,70,75,79,80,82,86

When there is an even number of cases, there is no actual middle item and the median is taken to be the average of the values of the items lying on either side of $\left(\frac{N+1}{2}\right)$.

$$= \frac{10+1}{2} = 5.5$$

Median, here will be mean of two middle terms *i.e.* $5th$ and $6th$ term

$$= \frac{75+79}{2} = \frac{154}{2} = 77$$

Calculation of Median from Grouped Frequency Distribution

Here, the cumulative frequency corresponding to each class boundary is first calculated.

Median is calculated by following formula

$$Median = L + \frac{\frac{N}{2} - pcf}{f} \times i$$

$where, pcf = \ Precending\ cumulative\ frequency\ to\ the\ median\ class$
$f = \ Frequency\ of\ the\ median\ class$
$i = Class\ intervals$
$N = Total\ number\ of\ cases$

Illustration: Find median from the following data

Gross Profit as percent of sales	Number of Companies
$0-10$	21
$10-20$	32
$20-30$	43
$30-40$	34
$40-50$	23

Solution:

Gross Profit(%)	Number of Companies(f)	Cumulative Frequency
$0-10$	21	21
$10-20$	32	53
$20-30$	43	96
$30-40$	34	130
$40-50$	23	153
	153	

Here, total frequency, $N = 153$

Median is the size of the $\left(\frac{N+1}{2}\right)^{th}$ item

i.e. $\frac{153+1}{2} = \frac{154}{2} = 77th$ item.

It lies in the class $20-30$.

Hence, median class is $20-30$ of which lower limit 20.

Hence, median class is $20-30$ of which lower limit 20.

$$Median = 20 + \left[\frac{\frac{153+1}{2} - (53)}{43}\right] 10 = 25.5814 = 25.58\%$$

Thus, 25.58% is the median gross profit of the companies.

Mode

Mode is defined as the value of the variable which occur most frequently in the data set.

When the data is grouped in a frequency distribution, we must assume that the mode is located in the class with highest frequency.

$$Mode\ M = l + \left[\frac{d_1}{d_1 + d_2}\right] W$$

$where, l = Lower\ limit\ of\ the\ modal\ class$
$d_1 = Frequency\ of\ the\ modal\ class - frequency\ of\ the\ class\ just\ below\ it.$
$d_2 = Frequency\ of\ the\ modal\ class - frequency\ of\ the\ class\ just\ above\ it$
$W = Width\ of\ the\ modal\ class$

Relation between Mean, Median and Mode

In the case of grouped frequency distribution, mode cannot be determined accurately because the exact value of variable are not known. Then, mode is found out by empirical formula.

$$Mode = 3Median - 2Mean$$

9.3.3 Dispersion

A measure of dispersion may be defined as statistics signifying the extent of the scatteredness of items around a measure of central tendency. A measure of dispersion may be expressed in an 'absolute form' or in 'relative form'. It is said to be in an absolute form when it states the actual amount by it which the value of an item on an average deviate from a measure of central tendency. Absolute measures are expressed in concrete units. *e.g.* Rupees, kilogram etc.

A relative measure of dispersion is a quotient obtained by dividing the absolute measures by a quantity in respect to which absolute deviation has been computed. It is usually expressed in percentage form and used for making comparison between two or more distributions.

Following are different measure of dispersion

(i) Range
(ii) Quartile Deviation
(iii) Mean Deviation or the Average Deviation (MD or AD)
(iv) Standard Deviation (SD)
(v) Relative Dispersion
(vi) Lorenz Curve

Range:

The range is the simplest value of dispersion. It is the difference between the biggest value and the smallest value of the items of distribution.

$Range = L - S$

$where, L = Largest\ value$

$S = Smallest\ value$

Range calculated above is not useful for comparison if the observation are different units. Therefore, for the purpose of comparison a relative measure of range is required, which is called coefficient of range.

$$Coefficient\ of\ range = \frac{Largest\ value - Smallest\ value}{Largest\ value + Smallest\ value}$$

$$= \frac{L - S}{L + S}$$

Quartile Deviation (QD)

Range as a measure of dispersion has many limitations as it is based on two extreme observations. it fails to explain the scattering data within the range.

We already know that if a set of data is arranged in an order of magnitude, the middle value which divides the set into two equal halves is called the median. By extending this idea we can think of these values which divide the set into four equal parts. These values are denoted by Q_1,Q_2,Q_3 and are called the first, second and third quartile respectively, Q_2 being equal to median.

$Q_1 = Value\ of\ the\ \left(\frac{N}{4}\right) th$ item

$Q_3 = Value\ of\ the\ \left(\frac{3N}{4}\right) th$ item.

If N is the number of items, the Quartile Deviation (QD) is a measure of dispersion and is given by the formula:

$$Qd = \frac{Q_3 - Q_1}{2}$$

Where, Q_1 and Q_3 are lower and the upper quartiles respectively. The quartile deviation is also called *semi interquartile range.* This gives the average amount by which the two quartiles differ from the median. the relative measure corresponding to this is known as coefficient of quartile deviation. It is given by the following formula:

$$Coefficient\ of\ QD = \frac{Q_3 - Q_1}{Q_3 + Q_1}$$

Mean Deviation (MD)

The range and quartile deviation are not measures of dispersion in the strict sense since they do not involve the scattering around an average. To study the deviations from an average, we have to other measures namely mean deviation and standard deviation.

Mean deviation is obtained by calculating the absolute deviations of each observation from mean.

Mean Deviation for Ungrouped Data

To compute mean deviation for ungrouped data, the mean of the sample is calculated. Then, we substract the mean from every value in the data set and ignore the positive or negative signs. Finally, all these differences are added and this sum is divided by the number of items in the sample.

$$Absolute\ Mean\ Deviation = \frac{\sum |X - \overline{X}|}{N}$$

$where, X = Value\ of\ observation$
$\overline{X} = Sample\ mean$

$$N = Number\ of\ observation$$

Mean Deviation for Grouped Data

Mean deviation for a grouped or continuous frequency distribution can be calculated using following formula:

$$MD(About\ the\ mean\ \overline{X}) = \frac{\sum f|X - \overline{X}|}{N} = \frac{\sum f|d|}{N}$$

$where, X = Mid\ value\ of\ the\ class\ interval$
$f = Corresponding\ frequency$
$N = Total\ cumulative\ frequency$
$|X - \overline{X}| = Absolute\ value\ of\ the\ deviations$
$d = X - \overline{X} = Difference\ of\ the\ value\ of\ X\ from\ the\ average\ \overline{X}.$

Standard Deviation (SD)

The mean deviation ignores the ' + ' and ' − ' signs in the data. If the signs are also taken into account, the deviations are squared and added together. When this value is divided by number of observations, it gives the variance (σ^2). The square root of variance is standard deviation (σ). The standard deviation measures the absolute dispersion or variability of the distribution. The greater the amount of dispersion, the greater is the standard deviation.

Thus, standard deviation is defined as the positive square root of the squares of the deviation of all the sizes from their arithmetic mean.

$$Standard\ Deviation\ for\ Ungrouped\ Data\ is\ \sigma = \sqrt{\frac{\sum (X-\overline{X})^2}{N}}$$

$where, \overline{X} = Mean$
$X = Observation$
$N = \sum f\ (total\ no\ of\ observations)$

$\sum (X - \overline{X})^2 = The\ sum\ of\ all\ values\ of\ (X - \overline{X})^2$
$\sigma = Standard\ Deviation$

Standard Deviation for Frequency distribution

Formula for computing standard deviation for a frequency distribution is

$$SD = {}^{C}\sqrt{\frac{\sum fd^2}{N} - \left(\frac{\sum fd}{N}\right)^2}$$

$Where, 'C'\ is the\ class\ interval$

$d\ is\ ther\ deviation\ in\ terms\ of\ 'C'$
$f\ is\ corresponding\ value$
$d = \frac{X - \overline{X}}{C}$

Relative Measures of Dispersion
It includes ratio, percentage and coefficients. The coefficients include coefficient of variation, correlation, regression etc. The most commonly used measure of relative dispersion is the coefficient of variation.

Coefficient of Variation (CV) is the ratio of the standard deviation (σ) and mean ($\overline{X}$) that is expressed as percentage and has no unit.

$C.V = \frac{\sigma}{X} \times 100$

$where\ C.V = Coefficient\ of\ variation$
$\sigma = Standard\ Deviation$
$\overline{X} = Arithmetic\ mean$

It is used to study percentage departure of rainfall, percentage variation in production, land use, demographic structure etc.

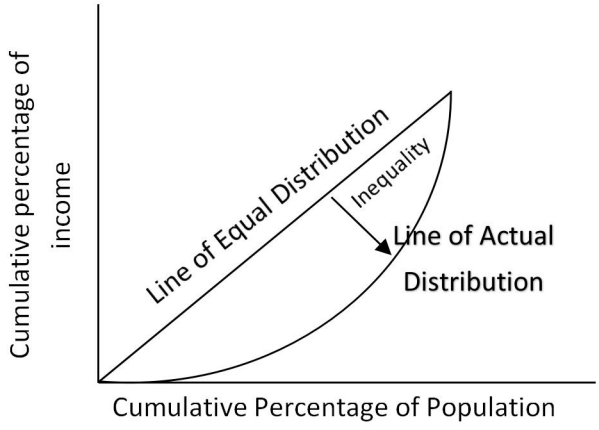
Coefficient of variation suggests the relative variability, homogeneity and stability of different series. Higher the value of CV, greater is degree of variability and lesser is the stability and homogeneity. Lower the value of CV, lower is degree of variability and higher is the homogeneity and stability of the series. Thus,

$CV \propto \frac{1}{stability}$

$CV \propto \frac{1}{homogeneity}$

Lorenz Curve
Lorenz curve is a graphic method of measuring variability. It was first used by American Economic Statistician Dr Max O Lorenz to study of the variability in money and income.

The curve is shown by the line of actual distribution from the line of equal distribution. If the line of actual distribution is closed to the line of equal distribution, the variability will be less. If the line of actual distribution is away from the line of equal distribution, the variability is more. If the line of actual distribution falls exactly on the line of equal distribution, there will be no variability.



Lorenz curve can be illustrated by a simple example. Suppose, 'n' population of a country has 'n' percent of its national income, then, the income will be equally distributed. Thus, 1% population will have 1% of its income, 2% population will have 2% income and so on. If the cumulative percentage of population is plotted along X-axis and corresponding share of income along Y-axis, the resultant graph will be known as *line of equal distribution*

9.3.4 Correlation

Correlation analysis can be referred as the statistical tool used to describe the degree to which one variable is related to another. Correlation is a statistical tool that helps to measure and analyse the degree or extent to which two or more variable fluctuate with reference to one another. For correlating two phenomenon, it is essential that the two phenomenon should have a cause effect relationship and if such relationship does not exist then the two phenomenon cannot to be correlated.

e.g. When demand of a certain product or commodity increases, then its price goes up and when its demand decreases then its price comes down. In this case both the phenomena have a cause effect relationship and thus, can be correlated.

Thus, correlation is concerned with relationship between two related and quantifiable variables and can be positive or negative.

Types of Correlation

Correlation is described or classified in several different ways. *They are*

i. **Positive or Negative Correlation** Whether the correlation is positive (direct) or negative (inverse) would depend upon the direction of change of the variable. The correlation is said to be positive or direct when the variations in two variables take place in same direction, but when variations in two variables take place in opposite directions, the correlation is termed as negative.

ii. **Single and Multiple Correlation** In single correlation, the relationship is confined to two variables and in multiple correlation the relationship is between more than two variables, e.g. Study limited to two variables-saving and rate of interest is a case of simple correlation. When another variable inflation is considered, it is a case of multiple correlation.

iii. **Partial and Total Correlation** There are two types of multiple correlation analysis partial and total. In the partial correlation, an analyst recognizes more than two variables, but considers only two variables keeping the other constant. On the other hand total correlation is based on al the relevant variables, which however is normally not feasible.

iv. **Linear and Non-linear (Curvilinear) Correlation:** Correlation is said to be linear, when the amount of change in one variable tends to bear a constant ratio to the amount of change in the other. The graph of the variables having a linear relationship will from a straight line.

Correlation is non-linear or curvilinear, if the amount of change in one variable does not bear a constant ratio to the amount of change in the other variable. e.g. If the rainfall is doubled, then it is not necessary that the yield also doubles.

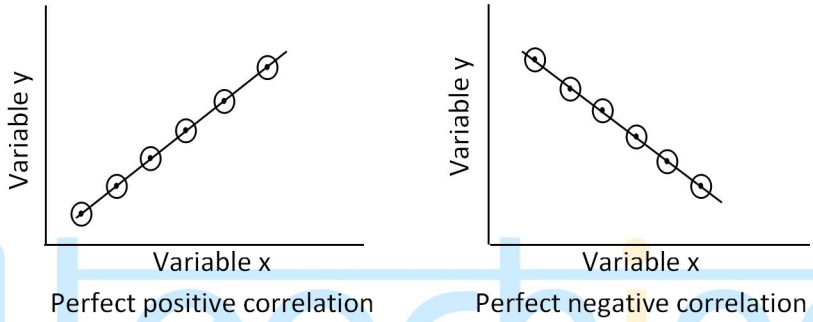
Methods of studying Correlation

The following are the important methods to find the correlation between variables

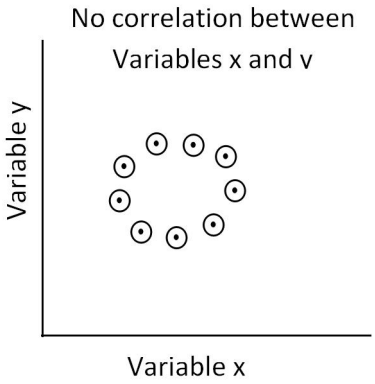
Scatter Diagram Method

In this method the given data is plotted on a graph paper in the form of does i.e. for each pair of variable we mark dots and thus obtain as many points as the number of observations. Generally, independent variables are plotted along the horizontal (X-axis) and dependent variable along the vertical Y-axis. The picture, so obtained is called as scatter diagram.

If the points are widely scattered over the XY-plane then the diagram indicate very low degree of relationship between the variables. If the points are widely scattered and rising from bottom left hand, to the top right hand corner, then the correlation would be of a lower degree, but positive. Similarly, if the points are scattered, declining from top right-hand corner to the bottom left hand corner, then the correlation would be of lower degree, but negative.



An exact degree of correlation between the variables cannot be established by adopting the Scatter Diagram method, though a rough idea of the direction of correlation can be well established.



Coefficient of Correlation

The coefficient of correlation is a measure to describe how well one variable is explained by another. It measures the degree of relationship between the two casually related variables. The coefficient of correlation is symbolically denoted by 'r'. + 1 and – 1 are the limits of the coefficient of correlation.

Karl Pearson's Coefficient of Correlation

This is a mathematical method to calculate the coefficient of correlation. The coefficient of correlation is denoted by 'r', which is a measure of the degree of linear relationship or correlation between two variables say 'x' and 'y' one of which happens to be an independent variable and the other being a dependent variable.

The Person's correlation coefficient between two variables 'x' and 'y' is defined as the ratio of the covariance between 'r' and 'y' to the product of standard deviation of x and y and is expressed as

$$r_{(x,y)} = \frac{cov(x,y)}{\sigma x\, \sigma y} = \frac{\sum xy/N}{\sigma x\, \sigma y} = \frac{\sum xy}{N\sigma x\, \sigma y}$$

Where, $x = x - \overline{X}$

$y = y - \overline{Y}$

$\sum xy =$ Sum of the product of deviations of x and y with reference to their arithmetic mean

$\sigma x =$ Standard deviation of series $X = \sqrt{\frac{\sum x^2}{N}}$

$\sigma y =$ Standard deviation of series $Y = \sqrt{\frac{\sum y^2}{N}}$

$N =$ Total number of items

The value of the coefficient of correlation shall always be: $-1 < r < +1$.

When the value of $r = +1$, the correlation between the variables is perfect and positive and when $r = -1$, the correlation is said to be perfect and negative. When the value of $r = 0$, then exists no correlation between the variables.

The main advantage of this method is that it summarises in one value, the degree of correlation and also the direct positive or negative of the correlation as well. But the limitation of this method is that the value of correlation coefficient is affected by extreme value and it is more time consuming then other methods.

Spearman's Rank Correlation Coefficient

In this method a rank is assigned to each value of a variable. This method is especially useful, when quantitative measure of certain factors involving quantity or quality cannot be fixed. Thus, individuals belonging to a group can be arranged in order by assigning a number indicating a rank to each individual of the group. E.g. Evaluation of leadership skills and ability of an individual may use this method.

In this method the rank correlation coefficient is a applied to a set of ordinal rank with 1 for individual ranked first in quantity or quality and so on, to N for the individual ranked last in a group of N individuals or N pairs of individuals.

It is expressed as

$$R = 1 - \frac{6\sum D^2}{N(N^2 - 1)}$$

Where, R = Rank coefficient of correlation

D = Difference of rank between paired items in two series

N = Total number of observations

The rank correlation coefficient also lies between - 1 and + 1.

When $R = +1$, it can be inferred that there is complete agreement in the order of the ranks and ranks are in the same direction.
When $R = -1$, then it can be inferred that there is complete agreement in the order of the ranks and are in the opposite direction.

9.3.5 Regression Analysis
This technique is used to determine the statistical relationship between two or more variables and to make prediction of one variable on the basis of one or more other variables. In regression analysis, there are two types of variables, the dependent variable is known as *regressed* (or explained) and independent variable is known as *regresser* (or predictor or explanatory) variable.

Utility of Regression Analysis
Regression analysis provides estimates of values of the regressed variables from the values of regresser variables.

Regression analysis also help to obtain a measure of the error involved in using the regression line as a basis for estimation. For this purpose, standard error of estimate is calculated. An estimate can be good, if the regression line fits the data closely. Further, regression analysis also helps in obtaining a measure of the degree of association or correlation that exists between the two variables.

Simple Regression
Simple linear regression occurs when one wants to predict values of one variable on the basis of given values of another variable e.g., we might want to predict a person's height (in inches) from his weight (in pounds).

Multiple Regressions
It estimates the relation between variables taking into account several additional (third) variables, e.g. Estimation of the gain in weight due to quitting smoking, taking into account the age, race, level of education, duration of follow-up, changes in physical activity and reproductive history.

Standard Multiple Regression
It is the same idea as simple linear regression, except that now we have several independent variables predicting the dependent variable. To continue with the previous example, imagine that we now have to predict a person's height from the gender of the person and from the weight. We would use standard multiple regression, in which gender and weight were the independent variable and height was the dependent variable.

The resulting output would tell us a number of things. First, it would tell us how much of the variance of height was accounted for by the joint predictive power of knowing a person's weight and gender. This value is denoted by 'R2'. The output would also tell, if the model allows us to predict a person's height at a rate better then chance.

This is denoted by the significance level of the overall F of the model. If the significance is 0.05(or less) then the model is considered significant. In other words, there is only a 5 in 100 chance that there is not a relation between height, weight and gender. For whatever reasons,

within the social science, significance level of 0.05 is often considered the standard. If significance levels are between 0.05 and .01 then the model is considered marginal.

In other words, the model is fairly good at predicting person's height but there is a 5-10% probability that there is not any really relationship between height and weight and gender.

Regression Line

It is a tool used for estimating the value of one variable from the value of the other. It is a line through the points drawn in such a manner as to represent the average relationship between the two variables.

Regression line gives the best estimate to the value of one variable for any specific value of the other variable.

The equation for a straight line, where the dependent variable Y is determined by the independent variable X is

Y = $a + bX$
a = Y interrupt (Interrupt on $Y - axis$)
b = Slope of the line
X = Independent variable
Y = Dependent variable

Assumptions in Regression Analysis

While making use of the regression techniques for making predictions following assumptions are made.

(i) There exists an actual relationship between the dependent and independent variable.

(ii) The values of the dependent variable are random, but the value of the independent variable are fixed quantities without error and are chosen by the analyst itself.

(iii) The regression analysis is used to estimate the value within the range, for which it is valid and not for values outside its range.

(iv) The relationship that existed between the dependent and independent variable remains the same till the regression equation is calculated.

(v) In regression we have only one dependent variable in our estimating. However, we can use more than one independent variable.

Similarly, if 'X' is the dependent variable and 'Y' is the independent, the equation will be $X = C + dY$

For two variable X and Y there are always two lines of regression, regression line of 'X' on 'Y' and regression line of 'Y' on 'X'.

In a case, where is there is either perfect positive correlation or perfect negative correlation between the two variables the two regression lines will overlap and hence, only one line appears.

The distance between the two regression lines is the determining factor or degree of correlation between the two variables under study. If two regression lines are far from each other, then degree of correlation is less and on the other hand, if two regression lines

are closed to each other then degree of correlation is high. If the variables are not at all related, the lines of regression are at right angles to each other. Further, the two regression lines intersect at the point of average of X and Y.

9.3.6 Hypothesis of Testing

A hypothesis is an approximate assumption that a researcher wants to test for its logical or empirical consequences. Hypothesis is regarded as a convenient mathematical approach for simplifying cumbersome calculation. Setting up and testing hypothesis is an integral art of statistical inference.

The 'testing of hypothesis' starts with an assumption or guess, termed as hypothesis that is made about a population parameter. The 'testing of hypothesis' is a process of tasting the significance of a parameter of the population on the basis of a sample. In 'tasting of hypothesis' we compute a statistic (it is the characteristic of a sample) from the sample drawn art of the population to verify whether the drawn sample belongs to the same population. It is always possible that value of the statistic differs from the assumed value. If the difference is too small, there is likelihood that guested or hypothesised value is correct. if difference is too high, the hypothesised value might be incorrect.

9.3.6.1 Types of Hypothesis

There are two types of hypothesis, which are as follows

Null Hypothesis

A hypothesis stated in the hope of being rejected is called a null hypothesis and is denoted by H_0.

Alternative Hypothesis

If H_0 is rejected, it may lead to acceptance of an alternative hypothesis denoted by H_1 . in other words, if sample results fail to support the null hypothesis, we must conclude that something else is true. Which is termed as alternative hypothesis.

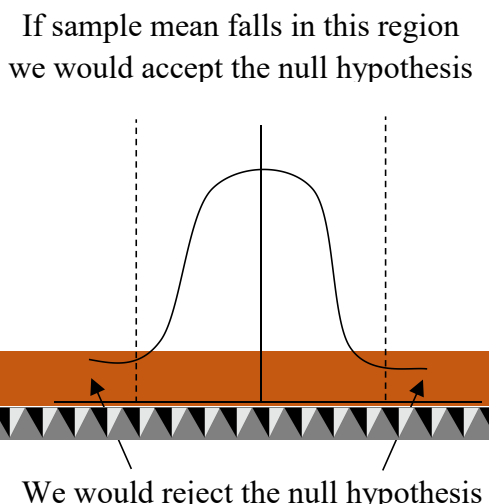
e.g. A dice is to be rolled a number of times to test a hypothesis

The null Hypothesis H_0:$P = {}^1\!/_6$ for showing six.

The alternative hypothesis $H_1 = P \neq {}^1\!/_6$.

9.3.6.2 Two Tailed and One Tailed Test of Hypothesis

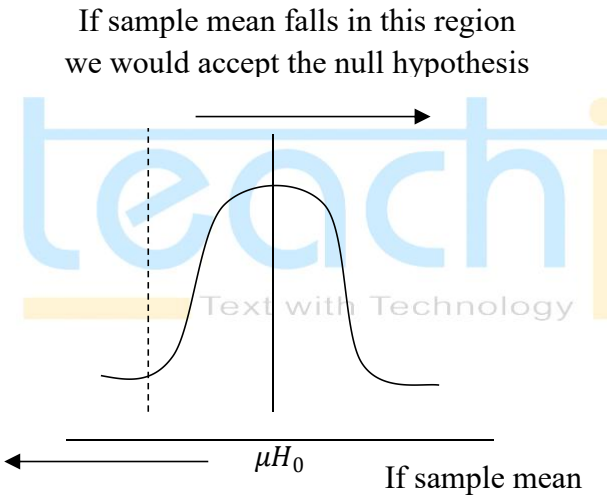
A two tailed test rejects the null hypothesis if the sample mean is either more or less than the hypothesised value of the mean of the population. it is considered to be apt when null hypothesis is of some specific value where as alternative hypothesis is not equal to the value of null hypothesis. In a two tailed curve there are two rejection regions, also called critical regions.



Two Tailed Test

When the population mean is either lower or higher than some hypothesised value, one tailed test is considered to be appropriate.

In one tailed test, the region of rejection lies at one end of the sampling distribution. Where the rejection region is only on the left tail of the curve it is known as left tailed test. Where the rejection region is only on the right tail of the curve. It is known as right tailed test.



One Tailed Test (Left tailed) One Tailed Test (Right tailed)

9.3.7 Small Sample Test

The sampling theory concerning large samples do not hold good, when we deal with small samples.

When samples are small, we cannot assume that random sampling distribution is approximately normal i.e. sample values are approximately equal to those of the parent data. Hence, new technique is necessary for handling small samples.

In case of small samples our main object is to test a given hypothesis. In other words, we try to ascertain whether observed values could have arisen by sampling fluctuations. In case of

small sample we should use relatively wide intervals as the result of small sample usually vary widely from sample to sample.

Various significant tests have been developed for dealing with problems of small samples.

The T-test , Z-test etc. are used to determine the reliability of the small samples i.e. arithmetic mean, standard deviation in case of small samples.

T-Test

T-test was developed by Sir William Cosset, which made significant contribution in the theory of sampling applicable in case of samples when population variance is not known. The test is known as t-test as it is based on T-distribution.

T-distribution is symmetrical like normal distribution, but flatter than it. There is different T-distribution for every possible sample size. As the sample size gets larger, the shape of the T-distribution loses its flatness and become approximately equal to normal distribution.

When 'n' is small the T-distribution is far from normal, but when 'n' is infinite it is identical with normal distribution. For applying t-test in context of small samples the t value is calculated first and then compared with the table value of t at certain level of significance for given degrees of freedom.

If the calculated value of t exceeds the table value $(say\ t_{0.05})$ we infer that the difference is significant at 5% level, but if 't' is less than the concerning table value of the 't' the difference is not treated as significant.

Chi-square Test

Chi-square is a test statistic used to rest a hypothesis that provides a set of theoretical frequencies with which observed frequencies are compared. Chi-square, symbolically written as X^2 enable us to test and compare whether more than two population proportions can be considered equal.

Hence, it is a non-parametric test of statistical significance, which compares observed data with expected data and testing the null hypothesis, which states that there is no significant difference between the expected and the observed result.

The Chi-square (X^2) is computed by using the following formula.

$$X^2 = \frac{\sum (O - E)^2}{E}$$

Where, O represents the observed frequency. E represents an expected frequency.

Whether or not a calculated value of X^2 is significant, can be ascertained by looking at the tabulated values of X^2 for given degree of freedom at a certain level of confidence (generally 5% level is taken). If the calculated value of X^2 exceeds the table value, the difference between the observed and expected frequencies is taken as significant but if the table value is more than the calculated value of X^2, then the difference is considered as insignificant.

Insignificant value is considered to have arisen as a result of chance and such can be ignored.

9.3.8 Times Series Analysis

It is defined as the chronological arrangement of successive values of a variable plotted on a graph. e.g. the production figures of a commodity from year to year, annual rainfall, decennial population figures etc.

The time series analysis can be performed in four general ways, these are also known as the components series analysis.

(i) **Secular Trend** A long term variation, either positive or negative as may be the case with cultivable agriculture land.

(ii) **Cyclic Variation** Regular fluctuation. e.g. Annual data of rainfall.

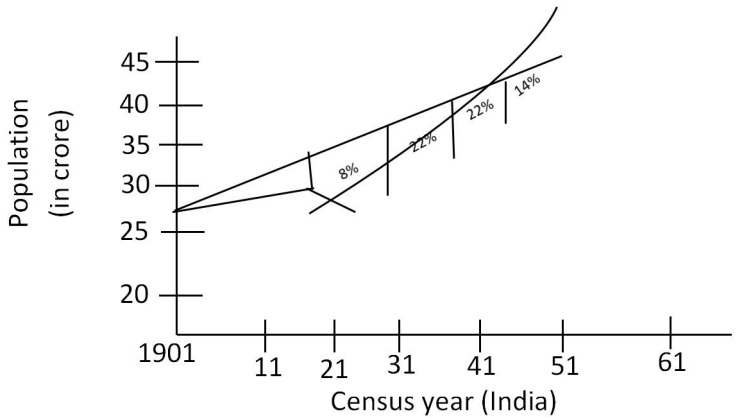
(iii) **Seasonal Variation** Variation in data according to seasons. e.g. Data of production of crops.

(iv) **Irregular Variation** Variations due to random or irregular causes.

The trends in time series analysis can be of straight line, parabolic or exponential. e.g. Production of a commodity follows a straight line and population growth follows an exponential trend. To assess the best fit curve, one has to measure the differences in the variables. If the first difference are more or less constant, a straight line will fit, if the second difference is constant, a parabola of second degree will fit. An exponential curve will fit when the log values of variate are constant. A logistics curve resembles an O' give which gives the best fit curve for the growth of population.

The exponential curve has been used by A Geddes for measuring the variability index of population. The relevant population figures are plotted and the trend curve is superimposed over it. The variations of actual and trend curve is noted as percentage. If the deviations are

noted at 'n' points, the summation divided by $(n + 1)$ gives the variability index. In practise, the trend line is taken as straight line joining the inter censal plotting.



In the given plotting, the deviations noted at H points – 8%, 22%, 22%, and 14%.

The variability index.

$$(v) = \frac{8 + 22 + 22 + 14}{5} = \frac{66}{2} = 13.2\%$$

In the moving average method, the curve becomes smooth by taking the average of variates for 3,4 or 5 periods etc. e.g. The running average of 5 variables will be.

$$\frac{x_1 + x_2 + x_3 + x_4 + x_5}{5}, \frac{x_2 + x_3 + x_4 + x_5 + x_6}{5}$$

9.3.9 Sampling

Sampling is a technique, which helps us in understanding the parameters or characteristics of the universe or population by examining only a small part of it. It is necessary to take a representative sample from the population, since it is extremely costly, time consuming and cumbersome to be a complete census. If the sample is truly representative of the population, then characteristics of the sample can be considered to be the same as those of the entire population. The part of population which is chosen to study and make the inference is known as the *sample.* e.g. a small amount of blood sample taken from a patient can determine whether the patient's sugar level is normal or not. This is so because the small sample of blood is truly representative of the entire blood in the body.

Characteristics of a Good Sample

While selecting a sample one should look out for the following characteristics

- A sample should have all the characteristics of the population from where it is taken.
- Person collecting sample should not be biased in selecting sample.
- The findings or decisions taken based on the sample study should be applicable to the entire population.

Types of Sampling

There are two methods of selecting samples from the population

(i) **Random or Probability Sampling** In random or probability sampling, the decision whether a particular element is included in the sample or not is governed by the chance alone.

(ii) **Non-Random or Judgement Sampling** Any sampling process which does not ensure some non-zero probability for each element in the population to be included in the sample would belong to the category of non-probability sampling. In this case, samples may be picked-up based on the judgment or convenience of the enumerator.

Methods of Sampling

Some of the random sampling methods are

(i) **Simple Random Sampling** It is one of the simplest sampling designs and can work well for relatively small population. Under this each element has an equal probability of getting included in the sample. It is imperative to have a list of all the members of the population before a simple random sample can be picked-up. Such an exhaustive list of all population members is called sampling frame.

(ii) **Stratified Sampling** Although stratified sampling is more complex than simple random sampling, but significantly increase the statistical efficiency of sampling. The basis for using stratified sampling is the existence of strata such that each stratum is more homogeneous within and workedly different from another stratum. The higher the homogeneity within each stratum, the higher will be the gain in statistical efficiency due to stratification. A stratum can be conceived as sub-

population, which is more homogeneous than complete population. The members of a stratum are similar to each other and are different from the member of another stratum in the characteristics that we are measuring.

(iii) **Systematic Sampling** Systematic sampling proceeds by picking-up one element after a fixed interval depending on the sampling ratio.
e.g. If we want to have a sample of size 10 from a population of size 100, our sampling ratio would be $n/N = \frac{10}{100} = \frac{1}{10}$. We would therefore have to decide where to start from among the first 10 names in our frame. If this number happens to be 5, then sample would certain serial numbers 5, 15, 25….., 95 in the frame. It is to be noted that the random process establishes only the first member of the sample, the rest are pre-ordained automatically because of the known sampling ratio.

(iv) **Cluster Sampling** In cluster sampling, the population is divided into well defined groups or cluster. Then, few of these clusters are selected based on the assumption that they represent the entire universe. All the units of the selected cluster are studied to arrive at a conclusion. The selection of these clusters is done by using anyone of the above discussed sampling methods.e.g. When a pre-poll survey is conducted in an assembly segment, then the entire voting population is divided into clusters. Then, some clusters are selected as samples and every element of these clusters is studied to arrive at a final opinion regarding the entire population. Cluster sampling is used primarily because it allows for great economies in data collection costs, since, the travel related costs etc. are smaller.

(v) **Multistage Sampling** Sometimes the population is too large and scattered so collect sample in practical sense make a list of the entire population from which we need to draw a sample. For instance, when we want to take a sample of 1000 household in a state. At first stage, state will be divided into number of districts and then few districts are selected at random. At next stage, each district will be sub-divided into a number of villages and a sample of villages will be selected. In this way, at each stage the sample size price become smaller and our sample will selected.

Non-Random or Judgement Sampling Methods

Some of the non-random sampling methods are follows

i. **Judgement Sampling** In judgement sampling, the selection of the sample is based on the judgment of the manager, who is studying a situation. This method is also known as *purpose sampling or deliberate sampling.* This sampling method should be carried out by an expert in the field as his judgement will influence the final outcome of the study.

ii. **Convenience Sampling** This method based on the convenience of the researcher. The researcher uses the sources available to him to come to the conclusion.e.g. List of employees of an organization available to him can be taken to study the employees.

iii. **Sequential Sampling** Here, size of sample is not fixed in advance, but is decided as the sampling process takes place depending on the results of the first A number of sample lots are drawn in sequence one after another from the population depending on the results of the earlier sample. e.g. A manager drawn a lot from the inventory and tests it for acceptability. If it is acceptable, there will be no further sample required, but if it is found unacceptable, the entire stock will be rejected. So, when the results of the

first sample fall in near to acceptable standard the manager will go for another sample before deciding on the quality of the inventory.

iv. **Quota Sampling** Quota sampling is a method for selecting survey participants. In quota sampling, a population is first segmented into mutually exclusive sub-groups, just as in stratified sampling. Then, judgement is used to select the subjects or unit from each segment based on a specified portion e.g., an interview may be told to sample 400 females and 600 males between the age of 30 and 50. This means that individuals can put a demand on who they want to sample (targeting).

Previous Year Question

Paper-II, July – 18

1. Read the following statements and select the correct answer using the code given below Statements:

(a) Summation of ranks method is best suited to measure development levels, when data used are highly skewed.

(b) Summation of ranks method is quite simple and easy to handle.

(c) Z-Score method is the robust and most reliable among all the methods used to measure levels of development.

(d) Use of Principal Component Analysis method should be avoided if inter-correlation among different components of development weak or doubtful.

Code:

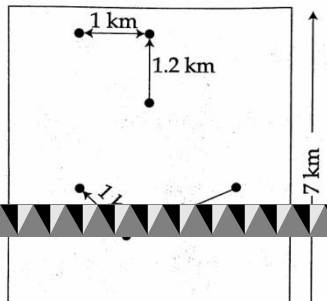
(1) (a), (b) and (c) are correct

(2) (a) and (b) are correct

(3) (a), (b) and (d) are correct

(4) (b) and (d) are correct

2. Which one of the following codes is correct R_n value of the given distribution of 6 settlements of an area of gentle topography?



(1) 0.95
(2) 1.45
(3) 1.63
(4) 1.86

3. A set of sample of 20 places of mean annual rainfall were randomly selected from a normally distributed universe that has mean annual rainfall of 320 cm. The sample mean was recorded 250 cm with standard deviation of 150 cm. Which one of the following significance tests is correct for the selected samples?
(1) $Z - test$
(2) $\chi 2$ – test
(3) $F - test$
(4) $t - test$

4. In a frequency distribution of X series having 6 integers with missing one, X_i, among them, the parameters of calculating mean, X, are as $\Sigma f(x) = 370$ (excluding frequency of missing X_i which is $f_i = 10$), $\Sigma f = 58$ (including frequency of missing integer) and $X = 7.586$. Which one of the following inters is approximately correct for missing X_i?
(1) 6
(2) 7
(3) 8
(4) 9

5. Which one of the following equations represents a true mathematical characteristics of mean?
(1) $\Sigma(X - X) = minimum$
(2) $\Sigma(X - X) = 0$
(3) $\Sigma(X - X) = maximum$
(4) $\Sigma(X - X) = infinite$

6. Which one of the following scales is correctly measure the rank-size distribution of settlements?
(1) Nominal
(2) Ordinal
(3) Interval
(4) Ratio

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	80	3	9.3.6
2.	93	1	9.3.4
3.	97	4	9.3.1, 9.3.2
4.	98	2	9.3.1, 9.3.2
5.	99	2	9.3.1
6.	100	4	

Paper-II, January – 17

1. Cumulative frequency distribution is shown by:
1. Histogram
2. Frequency curve
3. Pie diagram
4. Ogive

2. In linear regression equation, $Y = a + bX$, if mean of X and Y series are 23 and 94.5 respectively and slope gradient is 1.5, then what is the value of intercept a, in the distribution of (X, Y) series?
(1) 50
(2) 55
(3) 60
(4) 65

3. Match **List I** with **List II** and select the correct answer from the codes given below:

List- I (Value of R_n Statistics)	**List -II (Pattern of Distribution)**
I. < 0.5	A. Perfect uniform
II. 0.75 - 1.25	B. Tending to uniform
III. 1.75 - 2.00	C. Tending to uniform
IV. 2.15	D. Tending to cluster

Codes:	**(I)**	**(II)**	**(III)**	**(IV)**
1.	B	A	D	C
2.	A	B	C	D
3.	D	C	B	A
4.	C	D	A	B

Answer with Reference

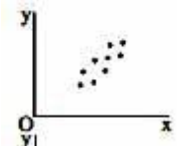
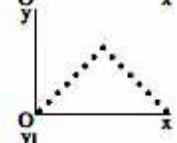
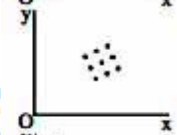
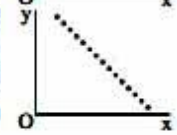
SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.

1.	46	4	9.3.0, 9.3.1, 9.3.2
2.	47	3	9.3.5
3.	49	3	9.3.4

Paper-III, January – 17

1. In order to study standard of living among the large, medium, small and marginal farmers of a region which of the sampling technique would be more appropriate?
(1) Random sampling
(2) Stratified Random sampling
(3) Opportunity sampling
(4) Multistage sampling

2. Match **List-I** with **List-II** and select the correct answer from the codes given below:

List-I (Scatter diagram)		**List-II (The degree of simple rank correlation)**
I.		A. $r = -1$, perfect negative
II.		B. $r = 0$, no correlation
III.		C. $r = < 1$ positive
IV.		D. $r = 1$ perfect positive

Codes: (I) (II) (III) (IV)
(1) C D A B
(2) D C A B
(3) C D B A
(4) A B C D

3. Which one of the following equations represents a true mathematical characteristic of mean?
(1) $S(X - X)2 = minimum$
(2) $S(X-X)2 = 0$
(3) $S(X - X)2 = minimum$
(4) $S(X- X)2 < S(X- X)$

Answer with reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	71	2	9.3.9
2.	73	3	9.3.4
3.	74	1	9.3.1, 9.3.2

Paper-II, November – 17

1. Which one of the following terms is used to measure the extreme peak in a normal distribution?
(1) Skewed

(2) Mesokurtic
(3) Leptokurtic
(4) Platykurtic

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	50	4	9.3.6.2

Paper-III, November – 17

1. Which one of the following terms is correct for calculation of Skewness Coefficient (β1)?

(1) $\beta_1 = \frac{\Sigma(X_i - \bar{X})}{n} \Big/ \frac{\Sigma(X_i - \bar{X})^2}{n}$

(2) $\beta_1 = \frac{\Sigma(X_i - \bar{X})^2}{n} \Big/ \frac{\Sigma(X_i - \bar{X})^3}{n}$

(3) $\beta_1 = \left[\frac{\Sigma(X_i - \bar{X})^2}{n}\right]^3 \Big/ \left[\frac{\Sigma(X_i - \bar{X})^2}{n}\right]^2$

(4) $\beta_1 = \left[\frac{\Sigma(X_i - \bar{X})^3}{n}\right]^2 \Big/ \left[\frac{\Sigma(X_i - \bar{X})^2}{n}\right]^3$

2. Given below are two statements, one labelled as Assertion (A) and the other labelled as Reason (R). Select your answer from the code given below:

Assertion (A): Standard Deviation of a series is the measure of its variation.

Reason (R): Standard Deviation is needed to compare the variation between two or more series.

Code:

(1) Both (A) and (R) are true and (R) is the correct explanation of (A).
(2) Both (A) and (R) are true, but (R) is not a correct explanation of (A).
(3) (A) is true, but (R) is false.
(4) (A) is false, but (R) is true.

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.

1.	70	4	9.3.1, 9.3.2
2.	71	2	9.3.3

Paper-III, July – 16

1. Distribution of monthly rainfall of a particular place for the month of June 2010 is given below:

Rainfall (cms.)	10-20	20-30	30-40
No. of days	6	20	4

Which one of the following calculated mean values of the distribution is correct?

Codes:

(1) 21.50
(2) 22.33
(3) 24.33
(4) 25.50

2. Which one of the following correlation coefficients is mismatched with its value?

(1) Perfect positive r = ± 1.0
(2) Imperfect negative r = –1.0
(3) No correlation r = 0.0
(4) Positive significant r = 0.5 < 1.0

3. Given below are two statements, one labelled as Assertion (A) and other Labelled as Reason (R). Select your answer from the codes given below:

Assertion (A): Partial correlation is a method of dealing with three or more variables.

Reason (R): Basically, it is the correlation between two variables holding the third variable constant.

Codes:

(1) Both (A) and (R) are true and (R) is the correct explanation of (A).
(2) Both (A) and (R) are true, but (R) is not the correct explanation of (A).
(3) (A) is true, but (R) is false.
(4) (A) is false, but (R) is true.

4. Given below are two statements, one labelled as Assertion (A) and other labelled as Reason (R). Select your answer from the codes given below:

Assertion (A): There are data restrictions in using Lorenz curve since variable must be expressed as frequencies and negative values cannot be included.

Reason (R): This technique is difficult to be applied to study of continuous variables.

Codes:

(1) Both (A) and (R) are true and (R) is the correct explanation of (A).
(2) Both (A) and (R) are true, but (R) is not the correct explanation of (A).
(3) (A) is true, but (R) is false.
(4) (A) is false, but (R) is true.

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.

1.	69	3	9.3.1
2.	71	2	9.3.4
3.	72	2	9.3.4
4.	73	2	9.3.3

Paper-II, Jun – 15

1. Which one of the following is correct?
(1) Arithmetic mean is a numerical value
(2) Arithmetic mean is not affected by the variability in the data sets
(3) Arithmetic mean is always a positive number

(4) Arithmetic mean is not useful for any further statistical analysis of the data

2. Which one of the following central tendencies is the appropriate method for the study of dispersion?
(1) Arithmetic mean
(2) Median
(3) Mode
(4) Geometric mean

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	46	1	9.3.1, 9.3.2
2.	47	2	9.3.3

Paper-III, Jun – 15

1. Which one of the following rearms shows variance of a particular distribution?

(1) $\Sigma (X - \bar{X})$

(2) $\Sigma(X-\bar{X})/N$

(3) $\Sigma(X - \bar{X})^2/N$

(4) $\left[\Sigma(X - \bar{X})^2/N\right]^{1/2}$

2. Assume there are four families in a country. The average per capita income of these families
is Rs. 5000. If the income of three families is Rs.3000, Rs. 4000 and Rs.7000 respectively, what is the income of fourth family?

(1) 7500
(2) 2000
(3) 3000
(4) 6000

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	73	3	9.3.1, 9.3.2
2.	74	4	9.3.1, 9.3.2

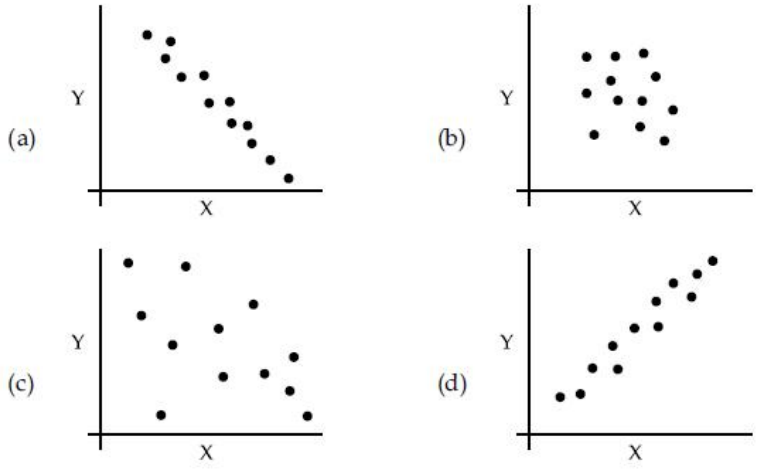
Paper-II, Decamber – 15

1. Match List – I with List – II and select the correct answer from the codes given below:

List – I **(Spatial Pattern)**	**List – II** **(R_n. Statistics)**
(a) Perfect Uniform	(i) 1.20
(b) Tending to Cluster	(ii) 2.14
(c) Tending to Random	(iii) 0.00
(d) Perfect Cluster	(iv) 0.60

Codes:	**(A)**	**(B)**	**(C)**	**(D)**
(1)	(iii)	(i)	(iv)	(ii)
(2)	(i)	(iii)	(ii)	(iv)
(3)	(ii)	(iv)	(i)	(iii)
(4)	(iv)	(ii)	(i)	(iii)

2. Which one of the following codes is correct to depict lesser degree of significance of given distribution?



Codes:

(1) (a) and (b)
(2) (a) and (d)
(3) (b) and (d)
(4) (b) and (c)

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	47	3	9.3.4

2.	48	2	9.3.4, 9.3.5

Paper-III, Decamber – 15

1. Which of the following exhibits "Cumulative percentages of population against cumulative percentages of area"?
(1) Gravity Model
(2) Beta Index
(3) Ogive Curve

(4) Lorenz Curve

2. Lorenz curve is used to find out which of the following?
(1) Relative concentration of a phenomenon
(2) Absolute concentration of a phenomenon
(3) Both relative and absolute concentration of a phenomenon
(4) Probability of dispersion of a phenomenon

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	37	4	9.3.1, 9.3.2
2.	74	1	9.3.3

Paper-II, Jun – 14

1. Cumulative frequency distribution is shown by
   (1) Histogram
   (2) Frequency Curve
   (3) Ogive
   (4) Pie diagram

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.

1.	50	3	9.3.1, 9.3.2

Paper-III, Jun – 14

1. Match **List– I** with **List– II** and select the correct answer from the codes given below:

List– I (Statistic)	**Lis– II (Analysis)**
a. Standard Distance	i. Principal Component
b. Nearest Neighbour	ii. Scatter diagram
c. Correlation	iii. Settlement pattern
d. Eigen Value	iv. Centrographic measure

Codes:	**(A)**	**(B)**	**(C)**	**(D)**
(1)	iii	iv	i	ii
(2)	iv	iii	ii	i
(3)	i	iv	iii	ii
(4)	ii	iii	iv	i

2. Mean, median and mode coincide if the distribution of values is
(1) Negativety skewed
(2) Normal
(3) Positivety skewed
(4) Poisson

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.

1.	61	2	9.3.3, 9.3.4, 9.3.5
2.	64	2	9.3.1, 9.3.2

Paper-II, Decamber – 14

1. Which one of the following statistical techniques involves a large number of variables to be summarised into smaller dimensions?
(A) Chi-square
(B) Correlation
(C) Factor Analysis
(D) Regression

2. Which one of the following averages is not a measure of central tendency?
(A) Harmonic mean
(B) Geographic mean center
(C) Geometric mean
(D) Arithmetic mean

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	46	3	9.3.7

2.	47	2	9.3.1, 9.3.2

Paper-III, Decamber – 14

1. Which one of the following circumstances Pearson's coefficient of Correlation is used?
(1) when the data set is positively skewed
(2) when the data set is negatively skewed
(3) when the data is normally distributed
(4) when the data is abnormally distributed

Answer with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.

1.	75	3	9.3.4

Sub Unit – 4:

Morphometric Analysis

……

9.4.0. Introduction:-

The term 'morphology of drainage basin' is used to describe the shape of drainage basin and the changes that occur in its shape and direction over a period of time. The morphology of drainage basin is a function of environmental conditions like rate of plant growth, composition of rocks, availability of sediment etc. and human interactions.

Following are the branches of morphology

(i) Qualitative Morphology or Geomorphological Mapping: It refers to the recognition of basic landscape units that can be easily identified in the field, on aerial photographs or from maps.
(ii) Quantitative Morphology or Geomorphometry: Geomorphometry is defined as the measurement and mathematical analysis of configuration of Earth's surface and of shape and dimensions of its land forms.

9.4.1. Morphometry of Drainage Basins:-
In geomorphology, morphometry is defined as measurement and mathematical analysis of configuration of Earth's surface and the shape and dimensions of its landforms. It includes quantitative study of the area, its volume, altitude, slope, profiles and drainage basin characteristics of the concerned area. It has two distinct branches

(i) Fluvial Morphometry: It includes the consideration of linear, areal and relief aspects of a drainage basin. Linear aspects deal with hierarchial orders of streams, length of stream etc. The areal aspects include analysis of perimeters, shapes area of basins, etc. Relief aspects includes besides hypsometric, clinographic, height curves, the study of absolute and relative relief, relief ratios etc.
(ii) Relief Morphometry: It includes analysis of terrain characteristics through hypsometric curves, clinographic curves, area height curves, altimetric curves, etc. which helps din dealing with different aspects of landform characteristics of a drainage basin.

Fluvial Morphometry:-
Fluvial morphometry incudes linear, areal and relief aspects of a basin. These are studied in terms of stream order, stream number land bifurcation ratio.

Stream Order:-
Stream order refers to the hierarchial position of a stream within a drainage basin. Stream ordering is studied as different branches of a stream have different characteristics. Gravelius first determined the order of stream network in 1914. He identified the main stream by tracing its source to the outlet. It was identified on the basis of greatest width, discharge, branching etc. and it was designated as 1st order stream. All of the steams joining the 1st order main stream were designated as 2nd order streams. All the streams joining the 2nd order streams were termed as 3rd order and it continued till the most remote tributaries were identified and assigned the highest order. Since, it was based on subjective decision of the investigator, so it was not appreciated.

Following are the schemes for studying stream order

Horton's Scheme of Stream Ordering:
According to Horton's scheme, "when two streams of same order meet, they form the next higher order. The stream order increases when two streams of same order join together. If a

stream of lower order joins a stream of higher order, the order of the receiving stream does not increase".

So, the ordering of streams being from the tip of tributaries which are considered as independent in terms of supply of water. These tributaries are designated as first order and when they join together, they form the second order streams. Two steams of second order meet, to make a stream of third order and this process continues till the main stream is given the highest order. As the first round of classification is complete, the steams are reclassified till the main stream becomes the longest drainage line of the basin.

Strahler's Scheme of Stream Ordering:
AN Strahler modified Horton's scheme of steam ordering by removing the problems of reclassification. He designated each finger tip channel as segment of first order. At the junction of any two first order segments, a channel of second order is produced and as this second order stream meets another second order segment, a stream of third order is produced. Thus, the hierachial order increases only when two steam segments of equal number meet at a junction. The order does not increase when a lower order steam meets a stream of higher order. Strahler's scheme is simple and can be derived mathematically as it designates all unbranched segments as same order. Strahler's scheme is popularly known as Stream segment Method.

Shreve's Steam Link Magnitude Method:
RL Shreve (1967) propounded his scheme of 'Stream Link Magnitude' based on 'interval scale' of steam ordering in which each exterior link or the 1st order segments is given a magnitude (m) of 1 and each 'successive link' is given a magnitude equal to the sums of all 1st order segments. Thus, combination (*) of links $M_1 \; and \; M_2$ gives a downstream link magnitude of $\mu_1 \; and \; \mu_2$. In Shreve's scheme, each segment (link) has its own contribution in increasing the magnitude (steam order) of the segment it meets. e.g. when two segments (links) meet, the magnitude increases to 4 $(2 + 2)$ down the confluence.

Scheidegger's Scheme of Stream Order:
Scheidegger presented his scheme of stream ordering based on 'ratio scale' measure which involves four postulates.

(i) When two similar segments (G') are combined the resulting segment has its order increased by an integer,
$G' * G' = G' + 1$

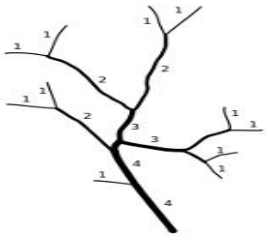
(ii) A combination of two segments of lower order $(G' - 1)$ with a given order should increase the order of the latter by one integer,
$G' * (G' - 1) * (G' - 1) = G' + 1$

(iii The sequence of joining of segments is immaterial,
$[G' * (G' - 1)] * (G' - 1) = G' * [(G' - 1) * (G' - 1)]$

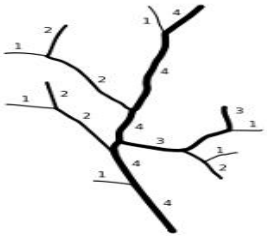
(iv) It does not matter whether G' segment joins a G'' or vice versa
$G' * G'' = G'' * G'$

MJ Woldenberg used Scheidegger's index and its relationship with basin bifurcation ratio to present his new scheme of stream ordering, which is as follows

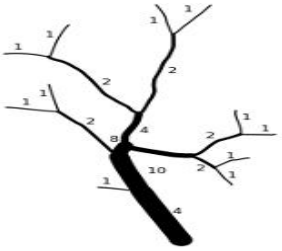
Stream ordering $W = \frac{\log M}{\log R_b} + 1$ where, $M = \frac{1}{2}$, $R_b = bifurcation\ ratio$



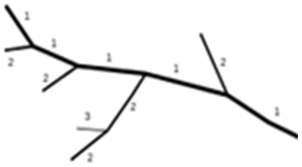
Strahler



Horton



Shreve



H Gravelius

Bifurcation Ratio:

The bifurcation ratio determines the branching pattern of drainage network. It is defined as the ratio, of number of streams of a given order (N_μ) to the number of streams of the net higher order $(N_\mu + 1)$

$R_b = \frac{N_\mu}{N_\mu + 1}$

Where $N_\mu = No.\ of\ steams\ of\ given\ order.$

$N_{\mu+1} = No.\ of\ steams\ of\ next\ higher\ order.$

It is a dimensionless property of drainage basin and is controlled by drainage density, junction angles, lithology, basin shapes, areas etc.

The following behavioural patterns of drainage ration have been identified according to studies of bifurcation ratio in different basins

- Mean bifurcation ratios show stable trends in a region of uniforms geological structure and lithologies but they show variable trends over varying geological structures.
- Mean bifurcation ratios register very small variation from region irrespective of the structural control. If any variation occurs, it may be due to environmental factors or morphometric control of the basin.

Stream Order (μ)	Number of steam (N_μ)	Bifurcation Ratio (R_b)
1	110	3.9
2	28	4.0

3	7	2.3
4	3	3.0
5	1	-

Stream Number:
RE Horton gave the law of stream numbers, which states that the number of steam segments of successively lower orders in a given basin tends of form a geometric series beginning with the segment of highest order and increases according to the constant. Bifurcation Ratio. e.g. If the order of main stream is 6 and the bifurcation ratio is 4, then the number of stream segments from the highest to lowest order (6,5,4,3,2,1) will be 1, 4, 16, 64, 256 and 1024 respectively.

Drainage Frequency:
Stream frequency, also known as drainage frequency is the quantification of number of steams per unit area. The basin is conveniently divided into grids of commonly 1 square kilometre in size. These girds are divided, depending upon the scale of map, areal coverage of basin and the number of streams in each grid are tabulated.

These are the general categories of stream frequency

- $Very\ poor - SF_{vp}$
- $Moderate - SF_m$
- $Very\ high\ -\ SF_{VH}$
- $Poor - SF_p$
- $High - SF_H$

The spatial distribution of frequency of stream can be depicted through isopleth or choropleth maps.

Density of Drainage:
Drainage density refers to the total steam lengths per unit area. RE Horton is 1945 defined the drainage density as the ratio of total length of all steams in a given drainage basin to the total area of that basin.

$D_d = \frac{L_K}{A_K}$

Where, $D_d = Drainage\ density.$
$L_K = Total\ length\ of\ all\ steams\ in\ a\ basin$
$A_K = Total\ area\ of\ all\ steams\ of\ basin.$

To calculate the drainage density on a regional scale, a basin is divided into grids of usually $1km^2$ in size and total length of all steams in measured in each grid to derive these categories of density of drainage:

- $Very\ low - Dd_{VL}$
- $Moderate -\ Dd_M$
- $Very\ high\ density - Dd_{VH}$
- $Low -\ Dd_L$

- $High\ density - Dd_H$

The spatial variation in drainage density is dependent upon precipitation effectiveness, vegetation, permeability of terrain, climatic character, relief, structure, geology etc.

Relief Morphometry:

The difference in altitude between the highest and lowest point in a given area is defined as relief. It describes the elevation of surface from the surrounding land. Relief is also the measure of energy head from which potential energy can be obtained. The valley forms, their variation with respect to space and time are influenced by relative relief.

Relief can be expressed in two ways

(i) Relative Relief: It is defined as the difference between highest and lowest points in altitude of a water divide in a given area. it is an important morphometric variable and is used for overall assessment of morphological characteristics of terrain and degree of dissection.

(ii) Absolute Relief:- Absolute relief or altitude indicates the altitude of the mountain or water divide from the sea level. It indicates the general nature of the topography and initial relief conditions.

Dissection Index/Relief Ratio:

The degree of dissection is represented by the index, which is the ratio between absolute and relative relief. The index is useful in the study of development of slopes within a region. The areas having low value of dissection index are generally the areas of high altitude as erosion agents are yet to do considerable work in these areas.

Relief Aspects of the Basin:

The relief aspects of the drainage basins are concerned with the study of three dimensional features of the basins which include area, volume and altitude of vertical dimension of landforms.

This study of three dimensional features of the basins involves the use of following morphometric methods to analysis terrain characteristics, which are the result of basin processes:

- Hypsometric curve
- Clinographic curve
- Altimetric curv
- Profiles of terrains and rivers
- Slope analysis

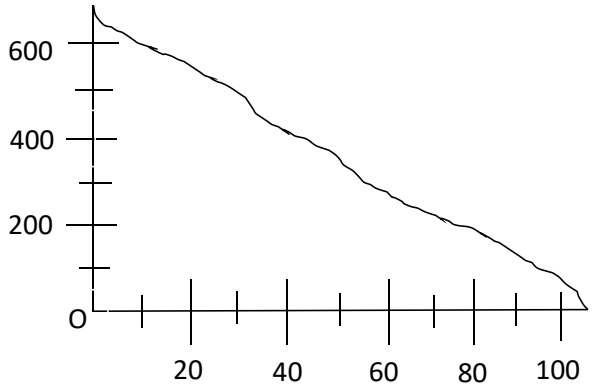
Hypsometric Analysis:

Hypsometry involves the measurement and analysis of relationship between altitude and basin area. It helps in understanding the degree of dissection and stages of cycle of erosion.

Area-height curves, hypsometric curves and percentage hypsometric curves are generally used to show the relationships between altitudes and area of the basin.

Hypsometric Curve:

It is generally used to show the proportion of area of the surface at various elevations above or below a datom. The values of area are plotted as ratios of the total area of the basin against the corresponding heights of the contours and the area is represented by cumulative percentage. However, the actual profile of terrain is not revealed by Hypsometric curve.



Cumulative area in per cent
Hypsometric Curve

Area Height Curve:

It indicate actual areas between two successive contours. The horizontal axis represents area in terms of percentage of total area and vertical axis show height. The area can be measured with help of planimeter or can be estimated by intercept method. The height is obtained from the contour map.

Thus, the area height curve denotes relationship between altitudinal zones and terrain is not represented by this curve and hence break in slope are completely concealed.

Clinographic Analysis:

Clinographic curves represent average slopes between successive contours.

Average slope angel between two successive contours $= \tan\theta = \frac{CI \times L}{A}$

Where CI= Contour interval
L= Total length of contour
A= Total area between contours

It presents a wide view of the terrain as clinographic curves reveal.
(i) break in slope
(ii) sudden changes in relief of the area.
(iii) general trend of the surfaces.

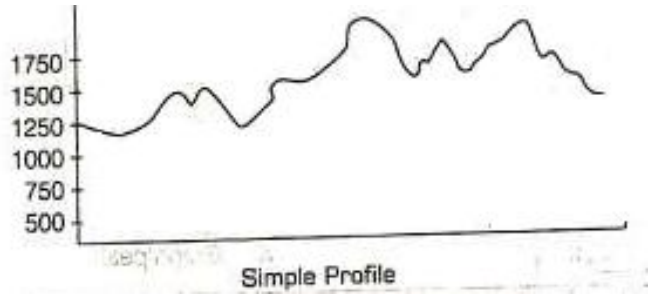
The construction of clinographic curve require data of slope angles between successive contours, contour lengths, heights and areas between successive contours.

Altimetric Analysis:
Altimetric refers to the numerical frequency of highlands and the summits of flats at various altitudes like spot heights, summits, shoulders, benches, etc. which demonstrate the existence of old erosion surfaces. Thus, it helps in identifying and determining erosion surfaces. Altimetric technique was adopted by H. Baulig in 1935 to study the flats and shoulders on valley sides. As all the summits area not of erosional origin, the reliefs are observed in the field and several altimetric histograms based on numerical data are drawn to achieve the accurate results using altimetric techniques. Altimetirc frequency histograms and curves represent frequencies of spot heights, summits, highest points in grid squares, summit areas, spot heights plus summit heights, etc. The nature of contour maps mainly determine the precision of altimetric analysis. A contour map having a contour interval of 5m or 10 feet is most suitable analysis. The procedure of drawing altimetric curve involves the counting of the number of spot heights, highest points, summits, measuring of areas of summits and lengths of shoulders and cols, tabulation of derived data in several height groups by using simple or running – sum class intervals.Then, the altitudinal groups are plotted along the y – axis while frequencies of numbers, areas, lengths, etc. as totals or percentage are plotted along the x – axis. Simultaneously, frequency histograms as well as curves are drawn for comparison and peaks of graphs are determined. This help in determining the frequency maxima and erosion surfaces.

Profile Analysis:
A topographic profile refers to a diagram that depicts the change of elevation of the land surface along a given line. Generally, profiles are of two types – river profiles and terrain profiles. Profiles provide a visual perception of the actual nature of terrain, thus, are of great assistance to geomerophologist who are concerned with the analysis of landforms and in the process of their gradation and denudation.

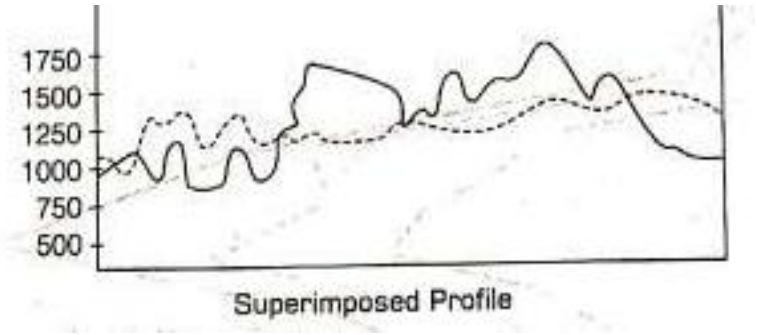
Terrain Profiles:
Terrain profiles are classified into serial profiles, superimposed profiles, projected profiles and composite profiles.

(i) Serial / Simple Profile: When a series of profile or parallel profiles are drawn, the profile is referred to as serial or simple profile. It helps in dep0icting features like a coastline, edges of plateau, a function of two contrasting topographical features, etc.



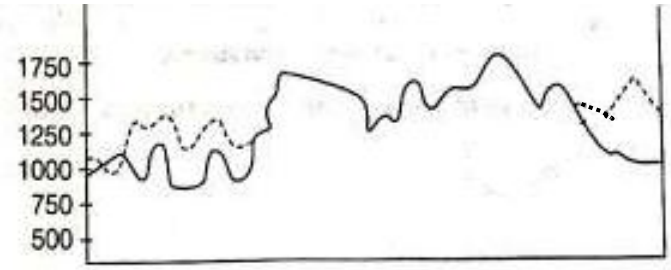
Simple Profile

(ii) Superimposed Profile: When a series of profile are superimposed on a single plane, it is called superimposed profile. It helps in determining different levels of planation surfaces.



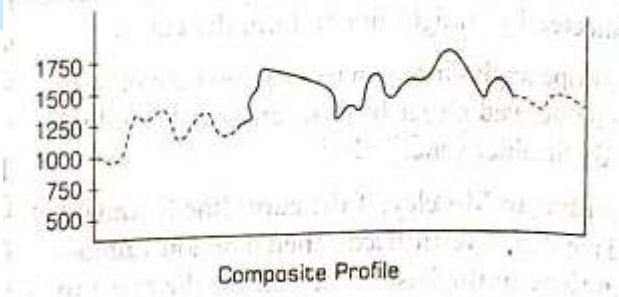
Superimposed Profile

(iii) Projected Profile: When only the visible parts of successive profiles are represented on a common framework, the profile is known as projected profile. It is also known as compressed profile. It give a wholistic view of the landscape of the region.



Projected Profile

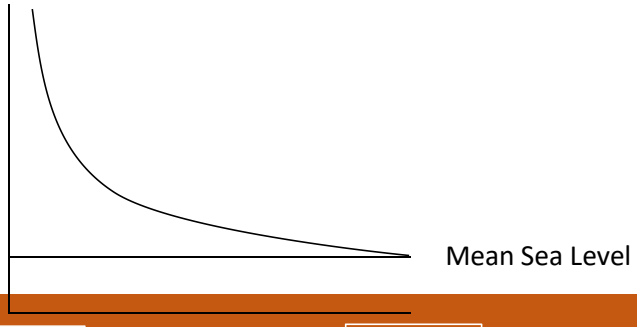
(iv) Compo parts of the summit levels as if seen from a distant place is called composite profile. It helps in comparative analysis of terrain types in a region or between regions.



Composite Profile

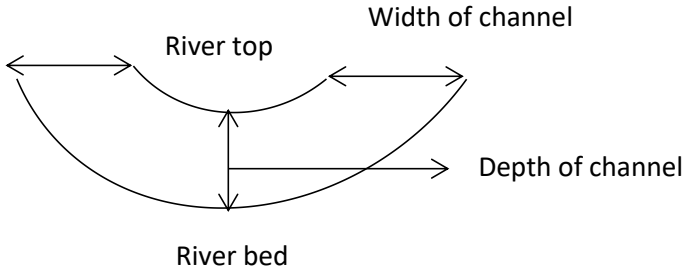
River Profile: River profiles are classified into longitudinal and transverse profiles.

(i) Longitudinal Profile: The profile depicting the gradient or slope of the river form source to the mouth is known as longitudinal profile of river.



Longitudinal Profile

(ii) Transverse Profile: The profile depicting the cross – section (width and depth) of the river valley is known as transverse profile of river.



Transverse Profile

Slope Analysis:-

Angular inclinations of terrain between hill tops and valley bottom is referred to as slope. It is a combinaiton of several factors like geological structure, ahsolute and relative reliefs, climare, vegetation cover, drainage texture and frequency, dissection index etc.From time to time several techiniques of the derivation and computation of average slopes from topographical maps have been suggested but the technique of Wentworth is easy and involves least measurement and calculation and more rapid procedure than orther schemes. Wentworth put forward his scheme of calculation of average slopes in degrees wherein the contour map of the region was divided inot grids of 1 km^2. Each region is having straight lines at right angles and the numberh of contou crossings along the edges of grid are counted and then the average number of contour crossings per km lingth is computed.The same process is repeated by using oblique grids over the same contour map of the region and again the average number of contour crossings per km are counted. Ultimately, the mean of two calculation gives abverage number of contour crossing per kilometer lentth. The tan values are derived and actual slope angles resulting from tan values are obtained from log table.

$$slope\ angle\ = tan\,\theta = \frac{N \times I}{3361} \text{ for FPs system} = \frac{N \times I}{636.6} \text{ for MKS system}$$

Where,
N = Number of contour crossings per kilometer length
I = Contour Interval
3361 = Constant for FPS system.
636.6 = Constant for metric system.

The vales of slope angles derived for each grid square of the drainage basin are tabulated and calssified into convenient slope categories

- $S_L : Level\ slope\ category\ = 0^0 - 2^0$

- S_G: $Gentle\ slope\ category = 2^0 - 5^0$
- S_{MS}: $Moderate\ slope\ category = 5^0 - 15^0$
- S_S: $Steep\ slope\ category = 15^0 - 30^0$
- S_{VS}: $Very\ steep\ slope\ category = above\ 30^0$

Isopleths are prepared for the study of spatial variations of average slope within the basin. The drawback of Wentworth scheme is that cliff slope angles cannot be computed on the basis of his formula.

Extra
Previous Year Question
Paper-III, Jun – 14

1. Match List_ – I with List_ – II and selecta correct answer using the codes given below:

List– I (Instruments)	List– II (Functions)
a. GPS base	i. Distance and area
b. Pantograph	ii. 3-D Vision
c. Planimeter	iii. Global location
d. Stereoscope	iv. Reduction & enlargement

Codes:	(a)	(b)	(c)	(d)
(1)	iii	i	iv	ii
(2)	ii	iv	iii	i
(3)	iii	iv	i	ii
(4)	i	ii	iii	iv

Answe with Reference

SL. NO.	QUESTION NO.	ANSWER	REFERENCE NO.
1.	66	C	