SURVEYING – I
UNIT I INDRODUCTION AND CHAIN SURVEYING

1. Define Surveying. What are the fundamental principles of surveying?

Surveying is an art of determining the relative positions of various points on, above or below the surface of the earth by means of direct or indirect measurement of distance, direction and elevation.

The principles of surveying are:

(i) Working from whole to part.

(ii)To locate a new station by at least two measurements (angular, linear) from fixed reference points.

2. What is the object or purpose of surveying?

The primary object of surveying is to prepare a plan or map to show the relative position of the objects on the surface of the earth. It is also used to determine the areas, volumes and other related quantities.

3. Name the different ways of classification of surveys.

a. Primary classification

(i). Plane surveying (ii). Geodetic surveying.

b.Secondary classification

(i). Based on instruments used (ii).Based on methods.

(iii). Based on object (iv). Based on nature of the field

4. Differentiate between plane and geodetic surveying.

Sl.No.	Plane surveying	Geodetic surveying.
1.	The curvature of the earth is neglected.	The curvature of the earth is taken.
2.	A line joining any two points is considered straight.	A line joining any two points is considered as curved line.
3.	The triangle formed by any three points is considered as plane triangle.	The triangle formed by any three points is considered as spherical triangle.
4.	It is done on a area less than 250 Km^2	It is done on a area greater than 250 Km^2

5. Define the constructions of a diagonal scale.

For a given short length (PQ=PR), draw a right angle triangle. Its base(PR) and height (PQ) are equal. A short length is divided into a number of parts by using the principle of similar triangles in which like sides are proportional.

Thus, 1-1 represents 1/ 10 PQ

9-9 represents 9/ 10 PQ

6. Define chain surveying. What is the fundamental principle of chain surveying?

Chain surveying is the type of surveying in which only linear measurements are made in the field.

The main principle of chain surveying or chain triangulation is to provide a framework consist of number of well-conditioned triangles or nearly equilateral triangles. It is used to find the area of the field.

7. What is a well-conditioned triangle? What is its specific advantage?

A triangle is said to be well- conditioned or well proportioned when it contains no angle smaller than 30^0 and no angle greater than 120^0.The main principle of chain surveying is chain triangulation. It consists of frame work of triangles. To plot the network of triangles accurately, the triangles must be nearly equal to equilateral or well-conditioned. The distortion due to errors in measurement and plotting should be minimum.

8. What are the operations involved in chain survey?

(i). Ranging: The process of locating intermediate points on a straight line between two end points in a straight line.

(ii). Chaining: The process of measuring the distance with a chain or tape.

(iii). Offsetting: The process of measuring the lateral distance of the object from the survey line to the left or right according to their positions.

9. What are the instruments required for a chain survey?

Chain or tape, Arrows, Pegs, Ranging rods, Offset rods, Laths or whites, Plumb bob, Cross staff and Mallet.

10. Write the different types of Chain.

(i). Metric chain (ii). Non-Metric chain

(a).Gunter's chain or Surveyor's chain (b). Engineer's chain (c). Revenue chain (d). Steel band.

11. Differentiate between Gunter's chain and Engineer's Chain

Sl.No.	Gunter's chain or Surveyor's chain	Engineer's chain
1.	It is 66 feet long and divided in to 100 links. 1link = 0.66 feet	It is 100 feet long and divided in to 100 links. 1link = 1 feet
2.	Measurements are in miles and furlongs.	Measurements are in feet and decimals

12. Define the terms:

(a).<u>Main stations</u>: Main station is a prominent point on the chain line and can be either at the beginning of the chain line or at the end or along the boundary.

(b). <u>Subsidiary stations:</u> The stations located on the main survey lines are known as Subsidiary stations.

(c). <u>Tie stations</u>: These are also subsidiary stations taken on the main survey lines to locate the details of the object.

13. Distinguish between a check line and a tie line.

Sl.No	Check line	Tie line
1.	Check lines or Proof lines are the lines which are run in the field to check the accuracy of the work	The main object of running a tie line is to take the details of the objects.
2.	The length of the check line measured in the field must agree With its length of the plan.	Tie line is a line which joints subsidiary stations or tie stations on the main line.

14. What are the instruments used for setting out right angles to a chain line?

(i). Cross staff.

a. Open cross staff b.French cross staff c.Adjustable cross staff

(ii). Optical square (iii). Prism square (iv). Site square.

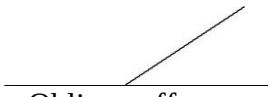
15. What are offsets? Classify them.

An offset is the lateral distance of an object or ground feature measured from a survey line. The two types of offsets are,

(i). Perpendicular offset: The angle of offset from a point on a chain line is 90^0

(ii). Oblique offset: When the angle of offset is other than 90^0 .

Perpendicular offset



Oblique offset

16. What is the use of a line Ranger?

The line Ranger is a small reflecting instrument used for fixing intermediate points on the chain lines. Without going to either end, we can fix the intermediate points.

17. What are the different sources of errors in chain surveying?

(i). Instrumental errors: incorrect length of the chain (Cumulative Errors).

18. What are the stages of fieldwork in chain surveying? Or what are the steps involved in chain survey?

- Reconnaissance: It is the preliminary inspection of the area to be surveyed.
- Marking and fixing Survey lines.
- Running survey lines.
- Taking Offsets.

19. What are the different tape corrections?

- Correction for absolute length or standardisation.
- Correction for temperature.
- Correction for pull or tension.
- Correction for sag. (- ve)
- Correction for slope. (- ve)

20. What are the errors in chaining?

(i). Compensating Errors: Which are liable to occur in either direction and tend to compensate.

(ii). Cumulative Errors: Which occur in the same direction and tend to add or subtract. It may be positive (measured lengths more than the actual length) or negative (measured lengths less than the actual length).

(iii). Personal error: Bad ranging (Cumulative Errors). Careless holding (Compensating Errors). Bad straightening (Cumulative Errors). Non- horizontality (Cumulative Errors). Sag in chain (Cumulative Errors). Miscounting and misreading and booking.

(iv). Natural Errors: Variation in temperature. (Cumulative Errors).

21. Enumerate the instruments used for measurement of lengths of survey lines.

(i). Chain or tape. (ii)Passometer. iii). Pedometer (iv). Odometern (v). Speedometer.

UNIT II
COMPASS SURVEYING AND PLANE TABLE SURVEYING

1. Define: Compass surveying. What are the objects of compass surveying?

Compass surveying is the type of surveying in which the direction of the survey lines are measured with a compass and the length of the survey lines are measured with a tape or chain in the field.

2. Write the names of the instruments used in chain surveying.

(i). Instruments for the direct measurement of directions:

a) Surveyor's compass. b). Prismatic compass.

(ii).Instruments for the measurement of angles: a) Sextant b) Theodolite.

3. Define the terms:

(a). True meridian and bearing:

True meridian:

The line or plane passing through the geographical North Pole, South Pole and any point on the surface of the earth, is known as true meridian or geographical meridian. True meridian at a point is constant.

True bearing:

The angle between the true meridian and a survey line is known as true bearing or Azimuth of the line.

(b). Magnetic meridian and Bearing:

Magnetic meridian :

Magnetic meridian at a point is the direction indicated by freely suspended, properly balanced and unaffected magnetic needle at that point.

Magnetic Bearing:

The angle between the magnetic meridian and a survey line is known as magnetic bearing or bearing .of the line. It changes with time.

4. What do you understand by Whole circle bearing and quadrantal bearing of a line?

Magnetic Bearings are designated by Whole circle bearing system and quadrantal bearing system.

In Whole circle bearing system (WCB), the bearing of the line is measured with magnetic north in clockwise direction. It varies from 0^0 to 360^0.

In quadrantal bearing system (Q.B or R.B) the bearing of the line is measured eastward or westward from north or south, whichever is nearer. The directions can be either clockwise or anticlockwise. It varies from 0^0 to 90^0.

5. Convert the whole circle bearing into reduced bearing: 50^0, 176^0, 210^0, 232^0, 150^0, 76^0, 310^0 ,242^0.

Whole circle bearing WCB	Reduced bearing RB
50^0	N 50^0 E.
176^0	S $(180^0 - 176^0)$E = S 4^0 E
210^0	S $(210^0 - 180^0)$W = S 30^0 W
232^0	S $(232^0 - 180^0)$W = S 52^0 W
150^0	S $(180^0 - 150^0)$ E = S 30^0 E
76^0	N 76^0 E
310^0	N $(360^0 - 310^0)$ W = N 50^0 W
242^0	S $(242^0 - 180^0)$W = S 62^0 W

6.What is its back bearing?

- In quadrantal bearing (RB) system, the FB and BB are numerically equal but the quadrants are just opposite.
- The FB of a line PQ is N 28^0 W, Then its BB is S 28^0 E .

7. Differentiate between Prismatic compass and Surveyor's compass with reference to reading and tripod.

SI.No.	Item	Prismatic compass	Surveyor's compass
1.	Reading	(i). The reading is taken with a help of prism provided at the eye slit. (ii). Sighting and reading taking can be done simultaneously from one position of the observer.	(i). The reading is taken by directly seeing through the top of the glass. (ii). Sighting and reading taking cannot be done simultaneously from one position of the observer.
2.	Tripod	Tripod may or may not be provided.	The instrument cannot be used without a tripod.

8. Define: Fore and Back bearing.

The bearing of a line is measured in the direction of the progress of the survey is called the fore bearing of the (FB) line.

The bearing of a line is measured in the direction opposite to the survey is called the back bearing of the (BB) line.

BB = FB $\pm$ 180 ^{0} . (FB greater than 180 ^{0}, use - sign) (FB smaller than 180 ^{0}, use + sign)

9. The fore bearing of line AB is 155^{0}25'20". Identify the back bearing of the line AB in quadrantal system.

The fore bearing of line AB = 155^{0}25'20". The back bearing of line AB , BB = FB + 180 ^{0}

= 155^{0}25'20" + 180 ^{0}
= 335^{0}25'20" (WCB)
= N (360^0 – 335^{0}25'20") W
= N 24^{0}34' 40'' W
=

10. Define and distinguish between magnetic dip and magnetic declination.

Magnetic dip:

Due to the magnetic influence of the earth, the needle does not remain in the balanced position. This inclination of the needle with the horizontal is known as the dip of the magnetic needle. To balance the dip of the needle, a rider (brass or silver coil) is provided along with it.

Magnetic declination:

The magnetic meridian of a place is variable one due to some local attractive forces. Therefore, the true meridian and the magnetic meridian at a place do not coincide. The horizontal angle between the magnetic meridian and the true meridian is known as magnetic declination.

11. The magnetic bearing of a line is 48^{0}24'. Calculate the true bearing if the magnetic declinations are 5^{0}38' East and 5^0 38' West.

True bearing = Magnetic bearing + Eastern magnetic declination
= 48^{0}24' + 5^{0}38'
= 54^{0}02'.
True bearing = Magnetic bearing - Western magnetic declination
= 48^{0}24' - 5^{0}38'
= 42^{0}46'.

12. The magnetic bearing of a line is S 28^{0}30' E. Calculate the true bearing if the magnetic declinations are 5^{0}38' East and 5^0 38' West.

Convert the reduced bearing into Whole circle bearing.

Magnetic bearing = S 28^{0}30' E. (RB)
= 180^0 - 28^{0}30'
= 151^0 30^0 .
True bearing = Magnetic bearing + Eastern magnetic declination
= 151^{0}30' + 7^{0}30'
= 159^{0}00'. (WCB)
= S(180^0-159^{0}00')E (RB)
= S 21 ^{0} E
True bearing = Magnetic bearing - Western magnetic declination
= 151^{0}30' - 7^{0}30'
= 144^{0}00'. (WCB)
= S(180^0-144^{0}00')E (RB)
= S 36 ^{0} E.

13. What is local attraction? What are the sources of local attractions?

Local attraction is a term used to denote any influence, such as magnetic substances, which prevents the needle from pointing to the magnetic north in a given locality.

The sources of local attractions are : magnetite in the ground, wire carrying electric current, steel structures, rails, underground iron pipes, chain etc.,

14. Distinguish between closed traverse and open traverse.

SI.No.	Closed traverse	Open traverse
1.	When the lines form a circuit, which ends at the starting point, it is known as closed traverse.	If the circuit ends elsewhere, it is Known as open traverse.
2.	It is suitable for locating the boundaries of lakes, woods etc,.	It is suitable for surveying a long narrow strip of land required for road canal etc,.

3.	Check: Sum of interior angles = (2n – 4) 90 Sum of exterior angles = (2n +4) 90 Where, n= number of sides of the traverse.	No direct check on angular measurements.

15. What is plane table surveying? When is it preferred? Write its principle.

Plane tabling is the graphical method of surveying in which the field observations and plotting proceed simultaneously.

It is mainly suitable for filling the interior details between the control stations and also in magnetic areas.

The main principle of plane table surveying is that the lines joining the points on the plane table are made to lie parallel to the corresponding lines joining the points on the ground while working at each station.

16. Name four methods of plane surveying.

i) Radiation ii) Intersection. iii) Traversing iv) Resection.

(i). Resection after orientation by compass.

(ii). Resection after orientation by back sighting.

(iii). Resection after orientation by three point problem.

a. Mechanical method.(Tracing paper method)

b. Graphical method. (Bessel's method)

c. Lehman's method. (Trial and error method) (iv). Resection after orientation by two point problem

17. When a three- point problem resorted to in plane table surveying?

It is the method of orientation when the table occupies a position not yet located on the drawing sheet.

This method is employed when during surveying the surveyor feels that some important details can be plotted easily by choosing any stations.

18. State the First and second Lehman's rule.

First rule: The distance of the point "p" (position of plane table on the drawing sheet) to be fixed from each rays Aa (paper a, to ground A), Bb (paper ,b to ground B) and Cc (paper c, to ground C) is proportional to the respective distances of the stations A, B and C from the ground station P.

Second rule: While looking towards the stations the point "p" to be fixed, will be either to the left or to the right of each of the rays.

19. What are the Advantages of plane table surveying?

1. It is useful in magnetic areas.
2. It is cheaper than the theodolite surveying.
3. It is most suitable for small-scale maps.
4. The surveyor can compare plotted work with the actual features.
5. No skill is required .

20. Name some of the errors in plane tabling.

1. Instrumental error.
2. Errors of plotting
3. Errors due to manipulation and sighting.
    1. Non horizontality of the board.
    2. Defective sighting.
    3. Defective orientation.
    4. Movement of board between sights.

UNIT III

LEVELLING AND APPLICATIONS

1. Define Levelling. What are the uses of leveling?

Levelling is a branch of surveying, the object of which is; (i). To find the elevations of given points with respect to a given or assumed datum, and (ii). To establish points at a given elevation or at different elevations with respect to a given or assumed datum.

2. Define benchmark and reduced level.

Benchmark:

Benchmark is a relatively permanent point of reference whose elevation with respect to some assumed datum is known.

Reduced level or Elevation:

The vertical distance of a point above or below the datum is known as the elevation or R.L of that point. R.L of a point may be positive or negative according as the point is above or below the datum.

3. What are the different kinds of bench marks?

A BM is the reference point of known elevation. It may be classified into following types.

(i).G.T.S Bench Mark: The great trigonometrical survey (G.T.S) bench marks are established by the survey of India throughout the country. The levels of this bench marks are established very accurately at a large interval with respect to the mean sea level at Bombay port.

(ii). Permanent Bench Mark: These are established by different Government departments like PWD, Railways, Irrigation etc,. The RL of these points are determined with reference to the G.T.S Bench Marks. Points on rocks, culvert, gate pillars, etc,.

(iii).Temporary Bench Mark: These are established temporarily whenever required. These are generally chosen to close the day's work and to start the next days. Points on roofs, walls, basements, etc,.

(iv). Arbitrary Bench Mark: When the RL of some fixed points are assumed, they are termed arbitrary benchmark.

4. What do you mean by datum surface?

It is any surface, to which elevations are taken as a reference for the determination of elevations of various points. In India the datum adopted for the great trigonometrical survey (G.T.S) is the mean sea level at Bombay port.

5. What is mean by line of collimation and height of collimation?

Line of collimation (Line of sight): It is an imaginary line passing through the intersection of the cross hairs at the diaphragm and the optical centre of the object glass and its continuation.

Height of collimation(HOC): The elevation of the Line of collimation (Line of sight) is known as Height of collimation. HOC = RL of BM + BS.

6. Write the different types of levels.

1. Dumpy level
2. Tilting level
3. Quick setting level.
4. Y-level.
5. Reversible level.
6. Automatic level
7. Lazer level.

7. List the essential parts of a Level.

Telescope, Eyepiece, Objective

Focusing screws. Longitudinal bubble

Foot screws, Upper parallel plate (Tribrach), Foot plate(Trivet).

Diaphragm adjusting screws, Bubble adjusting screws, Tripod.

8. What are the different type's leveling staffs?

1. Target Staff
2. Self reading Staff.
   a. Solid Staff
   b. Folding Staff
   c. Telescopic Staff.

9. Define and distinguish between 'Back sights' and 'Fore sight' in the process of fly Levelling.

SI.No	Back sights (BS)	Fore sight (FS)
1.	This is the first staff reading taken in any setup of the instrument. It is always taken on a point of known elevation(BM).	This is the last staff reading taken in any setup of the instrument and,afterthat instrument is shifted.
2.	It is used to determine the height of the instrument. HI = known RL + BS	It is used to determine the elevation (RL) of the staff station. RL = HI – FS.

10. What is the theory of direct leveling?

It is the branch of leveling in which the vertical distances with respect to a horizontal line may be used to determine the relative difference in elevation between two adjacent points. Steps involved:

HI = known RL(BM) + BS RL = HI – FS.

11. Distinguish between differential levelling and reciprocal levelling.

SI.No.	Differential levelling	Reciprocal levelling
1.	Difference in elevation between two or more points is determined by without any regard to the alignment of the points is called differential leveling.	Difference in elevation between two points is accurately determined by two sets of reciprocal observations..
2.	It is used when: (i). two points are a large distance apart. (ii). The difference in elevation between two points is large. (iii). Some obstacles intervenes between the points.	It is used when: (i). The instrument cannot be setup between the two points due to an obstruction such as a valley, river, etc,.

12. Reduced level of Bench Mark A - 50.000m
Reading on staff held at A - 2.435m
Reading on staff held at station point B - 1.650m
Find: (a) Height of collimation.
(b) Reduced level of station point B.
c) Rise/fall of B with respect to A.

(a). Height of collimation = RL of BM A + BS
(HOC) = 50.000 + 2.435
= 52.435m

(b) Reduced level of station point B.
= HOC – FS.
= 52.435 - 1.650
= 50.785 m

(c). Rise/fall of B with respect to A.
= 2.435- 1.65 (Lower staff reading being higher)
= 0.785m,
= with compare to A, the station point B being 0.785m higher.

13. Compare height of collimation method and rise and fall method.

SI.No	Height of collimation method	Rise and fall method
1.	It is more rapid, less tedious and simpler as it involves few calculation.	It is more laborious and tedious , involving several calculations.
2.	There is no check on the RL of the intermediate points.	There is a check on the RL of the intermediate points.
3.	Errors in intermediate RL's cannot be detected.	Errors in intermediate RL's can be detected.
4.	There are two arithmetic checks on the accuracy of RL calculation. $\sum BS - \sum FS$ = Last RL –First RL.	There are three arithmetic checks on the accuracy of RL calculation. $\sum BS - \sum FS = \sum Rise - \sum Fall$ =Last RL –First RL.
5.	It is suitable in the case of L.S and C.S, Contour etc.	It is suitable in fly leveling where I intermediate sights are less.

14. Write the formula for curvature correction, refraction correction and combined correction.

Curvature correction $C_C = 0.07849\ d^2$ (negative) m Refraction correction Cr = 0.01121 d^2 (positive) m Combined correction. $C = C_C - Cr = 0.06728\ d^2$ (negative) m.

Note: 'd' is to be substituted in Km, while the corrections will be in m.

15. List out the various sources of errors in leveling.

Three principal sources:

(i). Instrumental error
- a. Error due to imperfect adjustment
- b. Error due to sluggish bubble.
- c. Error due to movement of objective slide.
- d. Error due to defective joint.
- e. Error due to incorrect length of staff.

(ii). Natural error.
- a. Earth's curvature.
- b. Atmospheric refraction.
- c. Variations in temperature.
- d. Settlement of tripod.
- e. Wind vibrations.

(iii). Personal errors.
- a. Mistakes in manipulation.
- b. Mistake in staff handling
- c. Mistake in reading the staff.
- d. Error's in sighting.
- e. Mistakes in recording.

16. **List out the leveling problems.**

1. Levelling on Steep Slope.
2. Levelling on Summits and Hollows. 3.Taking Level of an Overhead Point.
4. Levelling Ponds and Lakes too Wide to be Sighted across.
5. Levelling across River.
6. Levelling on Past High Wall.

17. Define sensitivity of a bubble. State any two factors affecting the same.

The sensitiveness of a bubble is defined the angular value of one division of the bubble tube. It means the capability of showing small angular movements of the tube vertically. It can be increased by:

1. Increasing the internal radius of the tube.
2. Increasing the diameter of the tube.
3. Increasing the length of the tube.
4. Decreasing the roughness of the walls.
5. Decreasing the viscosity of the liquid.

18. What is a spire test?

It is used to make the horizontal axis perpendicular to the vertical axis. This test is also known as the test for the adjustments of the standards. It is done by means of the adjustments of the vertical hair. It is one of the permanent adjustment of the level and theodolite.

19. Define Contour, contour interval and, horizontal equivalent.

Contour: A contour is an imaginary line on the ground joining the points of equal elevation.

Contour interval: It is the vertical distance between any two consecutive contours. It depends upon the nature of the ground, the scale of the map and the purpose of the survey.

Horizontal equivalent: It is the horizontal distance between any two consecutive contours. It varies according to the steepness of the ground.

20. What are the different Characteristics of contour?

1. Contour lines are closed curves. They may either within the map itself or outside the map depending upon the topography.
2. Uniformly spaced, contour lines indicate a uniform slope.
3. A series of closed contours with increase in elevation from outside to inside in plan denotes a hill.
4. A series of closed contours with increase in elevation from inside to outside in plan denotes a depression.
5. The spacing between the contour lines depends upon the slope of the ground. In steep slopes, the spacing is small and for gentle slope, the spacing is large.

21. What are the uses of contours?

1. Volume of earthwork for any work can be estimated.
2. The capacity of the reservoir or the area of the catchments can be calculated.
3. Very useful in military operations to decide the position of the guns, the line of March.
4. Longitudinal and cross section can be drawn along any direction to know the nature of the ground.

22. Write the different formulae to calculate the area of the irregular plate.

1. By computations based directly on the field measurements:

(i). By dividing the area into number of triangles. (ii). By offsets to base line.

a. Mid ordinate rule $= \sum O \cdot d$
b. Average ordinate Rule $= \frac{nd}{n+1} \sum O$
c. Trapezoidal rule $= \left(\frac{Oo + On}{2} + O_1 + O_2 + O_3 + \ldots\ldots On_{-1} \right) d$
d. Simpson's rule $= [(Oo + On) + 4(O_1 + O_3 + \ldots. On_{-1}) + 2(O_2 + O_4 + \ldots. On_{-2})] (d/3)$

Oo = Ordinate at one end. On = Ordinate at other end.
$O_1 + O_2 + O_3 + \ldots\ldots On_{-1}$ = Ordinate at end of each divison. d = Length of the base

(iii). By latitudes and Departures:

a. By double meridian distance (D.M.D. method).
b. By double parallel distance (D.P.D. method). (iv). By co- ordinates.

2. By computations based on measurements scaled from a map.
3. By mechanical method: By means of planimeter.

23. How do you calculate the capacity of the reservoir from the contour map?

From the contour map, the capacity of the reservoir is calculated by the following formulas.

1. Trapezoidal rule = $(\frac{Ao + An}{} + A_1 + A_2 + A_3 + \ldots\ldots An\text{-}_1)$
2. Prismoidal rule = $[(\frac{Ao + An}{}) + 4(A_1 + A_3 + \ldots . An\text{-}_1) + 2(A_2 + A_4 + \ldots \ldots An\text{-}_2)] (d/3)$

Ao, A_1, A_2, A_3,……An = Areas enclosed by successive contours. d = contour interval.

UNIT IV
THEODOLITE SURVEYING

1.Define: Theodolite surveying. What are the uses of a theodolite?

Theodolite surveying is a branch of surveying, in which the theodolite is accurate instrument used for the measurement of horizontal angles, vertical angles. It can also be used for various purposes such as laying off horizontal angles, locating points on a line, prolonging survey lines, establishing grades, determining differences in elevation, etc,.

2. Why a type of theodolite is called a transit theodolite?

A transit theodolite is one is which the line of sight can be reversed by revolving the telescope through 180^0 in the vertical plane.

3. List the essential parts of a theodolite.

The telescope, The vertical circle, The index frame (T- frame), The levelling head, The scale plate (Lower), The Vernier plate (Upper). The tripod, Plumb bob, The compass, Focusing screws,The upper and lower clamp and its tangential screws, Vertical clamp screw, Foot screws. etc,.

4. Differentiate between the Vernier theodolite and Micrometer theodolite.

In Vernier theodolite the verniers are fitted to read the angles upto 20". In Micrometer theodolite micrometers are fitted to read the angles.

5. List the essential qualities of a theodolite telescope.

The essential parts of the telescope:

(i).Objective (ii).Eye-piece, (iii). Diaphragm, (iv). Body and focusing device.

The essential qualities of a theodolite telescope:

(i). The real image must be formed in front of the eye-piece.

(ii). The plane of the image must coincide with that of the cross-hairs.

6. What are the temporary adjustments of the theodolite?

1. Setting up.
2. Levelling up.
3. Elimination of parallax.

(i). Focusing the eye piece. (ii). Focusing the Objective.

7.List out the permanent adjustments of Theodolite.

1. Adjustment of plate level (Plate level test).
2. Adjustment of line of sight (Cross- hair test).
3. Adjustment of horizontal axis.(Spire test).
4. Adjustment of vertical index frame and altitude bubble. (Vertical arc test).

8. List out the fundamental lines of Theodolite

1. The vertical axis 2.The horizontal axis or trunnion axis
2. The line of collimation or line of sight. 4. Axis of plate level.
5. Axis of altitude level.

9. What is an anallatic lens? What is the use of an anallatic lens?

It is a special convex lens fitted between the object glass and eye piece, at a fixed distance from the object glass, inside the telescope of a tacheometer.

The use of an anallatic lens is to reduce the additive constant (C) to zero. Tacheometric

equation, D = Ks + C. Where, D = horizontal distance between the staff and the instrument station.
S = staff intercept, K = multiplying constant. C = additive constant.

10. Name the two methods of measuring horizontal angles using a theodolite. When each method is advantageously used?

The two methods: (i). Repetition method.
(ii). Reiteration method (Direct method).

The method of repetition is preferred for the measurement of a single angle. The method of reiteration is preferred in triangulation, where a number of angles may be required at one point by the instrument.

The method of repetition appears to be better, it is more time consuming and even many repetitions may yield ordinary results.

11. State what errors are eliminated by repetition method.

1. Errors due to imperfect eccentricity of verniers and centers' are eliminated by reading both verniers and taking the mean of the reading.

2. Errors due to imperfect adjustment of the instrument are eliminated by taking face left and right observations.

3. Errors due to inaccurate graduations on the main scale are eliminated as the readings are spread over different parts of the circle.

4. Errors due to inaccurate bisection of the signal are eliminated, as they tend to balance each other. All the errors are also minimized as the number of repetitions divides the sum.

12. What are the methods used to plot the traverse?

- By parallel Meridians through Each Station.
- By Included Angles
- By Paper Protractor.
- By rectangular co-ordinates.
- Plotting by tangents and chords.

13.Define closing error.

If a closed traverse is plotted according to the field measurements, the end point of the traverse will not coincide exactly with the starting point, due to the errors in the field observations. Such as error is known as closing error.

Closing error $e = \sqrt{(\sum L)^2 + (\sum D)^2}$.

where, $\sum L$ = sum of latitudes.
$\sum D$ = sum of departures.

The direction of closing error

$\tan \theta = \sum D / \sum L$.

14. Define: Balancing. What are the methods used to balancing the traverse?

The term balancing is generally applied to the operation of applying corrections to latitudes and departures. So that $\sum L$ = sum of latitudes = 0; $\sum D$ = sum of departures = 0. This is applied only for closed traverse

Methods used to balancing (adjusting) the traverse:

1. Bowditch's rule
2. Transit rule.
3. Graphical method.
4. Axis method.

15. Define the Bowditch's rule in balancing the traverse.

The Bowditch's rule (compass rule) is used to balance a traverse where the linear and angular measurements are of equal precision. In this method the error in linear measurements are proportional to $\sqrt{l}$ and the error in angular measurements are inversely proportional to $\sqrt{l}$,where l is the length of the line.

Correction to latitude (or departure) of any side

= Total error in latitude (or departure) x Length of that side / Perimeter of traverse.

$C_L = \sum L .(l / \sum l)$

$$C_D = \sum D .(l / \sum l)$$

where,

$\sum L$ = Total error in Latitude.

$\sum D$ = Total error in Departure. l = Length of the side

$\sum l$ = Perimeter of traverse.

16. What is Gale's table? What is its use?

Traverse computations are usually done in a tabular form. One such form is known as Gale's Table.

It is used to balance the traverse and also used to find the area of the closed traverse.

17. Define: Omitted measurements.

Sometimes it is not possible to take all the measurements due to obstacles. Such missing quantities are known as omitted measurements. They can be calculated from the known latitudes and departures.

18. What is closed traverse? What are the two checks applicable in this case?

When the lines form a circuit, which ends at the starting point, it is known as closed traverse.

Check:

(i). Sum of interior angles = (2n – 4) 90 (ii). Sum of exterior angles = (2n +4) 90

Where, n= number of sides of the traverse.

19. Define: Trigonometrical leveling or Heights and Distances.

Trigonometrical leveling is an indirect method of levelling. The relative elevations of various points are determined from the observed vertical angles and horizontal distances by the use of trigonometrically relations. The vertical angles are measured with a theodolite and the horizontal distances are measured with a tape or chain. This method is also known as Heights and Distances.

20. What are the methods used to find the elevations of the points in the case of inaccessible points? Differentiate that?

1. Single plane method
2. Double plane method.

SI.No.	Single plane method	Double plane method
1.	Two instrument stations are chosen in line with the object.	Two instrument stations are chosen which are not in line with the object.
2.	The two vertical angles are measured in the same vertical plane.	The two vertical angles are measured in two different vertical planes.
3.	Horizontal angles are not required.	Horizontal angles are also measured.

UNIT V

ENGINEERING SURVEYS

1. Why curves are necessary in the alignment of a highway/ railway?

During the survey of the alignment of a road, railway, canals, etc, the direction of the line may change due to some unavoidable situations. When two straights of a highway or rail way are at some angle to each other, a curve is introduced between them to avoid an abrupt change in direction and to make the vehicle move safely, smoothly and comfortably.

2. List the various types of curves. Types of curves:

1. Horizontal curve – provided in the horizontal plane.
    a. Simple curve
    b. Compound curve
    c. Reverse curve.

d. Transition curve.

2.Vertical curve – provided where two straight lines of different gradient intersect in the vertical plane.

a. Summit curve.

b. Sag curve.

3. What are the three classes of circular curves?

a. Simple curve - consists of single arc connecting two straights.

b. Compound curve - consists of two arcs of different radii bending in same direction. Centres being on the same side of the curve. c. Reverse curve - consists of two arcs of different radii or equal bending in opposite direction. Centers being on opposite side of the curve.

4. Define degree of curve according to highway practice.

The degree of a curve can be defined based on either an arc or a chord. According to the arc definition, the degree of a curve is the central angle subtended by an arc of 30 or 20 m length. In highways this arc definition is utilized.

According to the chord definition, the degree of a curve is the central angle subtended by an arc of 30 or 20 m length. In railways this chord definition is utilized.

5. State the relationship between the radius of a curve and the degree of the curve.

If the chord length is 30m, R= 1719 / D If the chord length is 20m, R= 1146 / D

Where, R = Radius of a curve

D = Degree of the curve

6. What are the elements of a simple Circular curve?

1. Back tangent 2. Forward tangent. 3. Point of curve. (P.C)- T_1
4. Point of tangency (P.T) - T_2. 5. Point of intersection (P.I).
6. Intersection angle (I). 7. Deflection angle or Central angle(φ).
8. Tangent length 9. External distance or Apex distance
10. Length of the curve 11. Long chord. (T_1 T_2). 12. Mid ordinate

7.Define: Setting out of curves(curve ranging).

Setting out of curves means the location of various points along the curve and joining the same to obtain the actual curves.

8. What are the methods used for setting curves?

The methods used for setting curves:

1. Linear methods.

(i). Offsets from long chord.

(ii). Radial offsets from tangents.

(iii). Perpendicular offsets from tangents. (iv). Successive bisection of arcs.

(v). Offsets from the chord produced.

2. Angular methods.

(i). Rankine's method of deflection angle.(One theodolite method)

(ii). Two- theodolite method.

(iii). Tacheometric method.

9. What is Sight distance in highways? Which factors affect if?

Sight distance may be defined as the minimum distance between two vehicles moving along a curve, when the driver of one vehicle can just see the other vehicle r ahead on the road. The factors affecting the sight distance are:

(i). Height of the line of the sight of the driver (ii). Grade or longitudinal slope of the curve
(iii). Speed of the vehicle. (iv). Co efficient of friction (v). Efficiency of the break.

10. What is meant by stopping sight distance?

It is the minimum distance necessary for the safe movement of traffic within which the driver of a vehicle moving at design speeds. After reaching to the presence of a hazard ahead, can bring it to a stop before reaching a hazard. It depends upon

(i). Grade or longitudinal slope of the curve (ii). Speed of the vehicle.

(iii). Co efficient of friction (iv). Efficiency of the break.

11. Define: transition curve.

A curve of varying radius is known as transition curve or spiral or easement curve. A transition curve is a non circular arc introduced on either sides of a circular curve or between the two branches of compound or a reverse curve. It is not provided in highways but is provided in railways.

12. What are the functions of a transition curve?

1. The radius of the curvature increases or decreases gradually.
2. It is provided for the gradual change in super elevation.
3. It allows a gradual transition of curvature from the tangent to the circular curve of from the circular curve to the tangent.
4. It eliminates the danger of derailment, overturning or side slipping of vehicles and discomfort to passengers.

13. What are the types of transition curve?

1. Cubic spiral or clothoid or Euler spiral – provided in Railways.
2. Bernoulli's Lemniscate.- provided in Highways
3. Cubic parabola or Froude's curve. - provided in Railways

14. What are the aims when undertaking setting out operations?

1. The structure to be constructed must be set out correctly in all three dimensions – both relatively and absolutely, so that it is of correct size, in the correct plan position and a correct level.
2. The setting out process, once begun, must proceed quickly, without causing any delay in construction program.

15. What are the controls required for setting out?

In horizontal control, control stations (Triangulation stations) must be established within or near the construction area. The well-known principle of working from whole to part is applied.

It consists of reference marks of known height relative to some specified datum.

16. What are the operations involved in setting out a tunnel ?

1. Surface survey
2. The connection of surface and underground surveys.
3. Setting out underground.
4. Levels in tunnels.

17.Define: Shafts

They are hollow vertical members. They are frequently sunk on the centre line of the tunnel setting out to facilitate construction by providing additional working faces.

18. Write the series of surveys conducted for the location of the roadways, railways, waterways.

1. Reconnaissance survey – Examination of the entire area and collect the required details. Select number of routes.

2. Preliminary survey - detailed instrumental examination of the entire area and finalize the route.

3. Location survey – set out the alignment of the decided route on the ground. Construction Survey – Prepare L.S and C.S. Begin the construction.

19. Define : Lead lines.

The lead lines, also called sounding lines are usually used for depth over 6m. The lead line consists of a line of hemp, cotton, or a brass chain having at its end a weight called a lead.

20. What are the instruments used for setting out tunnels?

Theodolite. Tape, Tripod,

16 MARKS

UNIT-1

1. Discuss in brief the principles of surveying?
2. Explain with neat sketch the construction of plain scale. Construct a plain scale 1cm=6m and show 26m on it.
3. Define surveying. What are the primary divisions of surveying?
4. Explain the construction and uses of scale of chords?
5. Write an essay on the care and adjustments of survey instruments.
6. What considerations would you have while selecting survey stations and survey lines in a chain survey?
7. Explain the working and use of the following:
    a. Open cross staff (i) French cross-staff (ii) Optical square (iii) Prism square
8. Describe various types of measuring chains used for linear measurements.
9. What is ranging? Explain direct ranging and indirect ranging in detail.
10. Explain the different methods of chaining on sloping ground.
11. What are the possible errors in chaining?
12. What are different tape corrections?
13. What are the factors to be considered in deciding the stations of a chain survey?
14. What is well conditioned triangle? Why is it necessary to use well-conditioned triangle?
15. Explain plotting of chain survey.
16. Explain the various methods of erecting a perpendicular at a point on the chain line.

UNIT-II

1. Explain clearly the two point problem and the method of solving it.
2. How would you determine the included angles from the bearings? Explain the method with the help of sketches.
3. What is declination? What are different types of variations in declination? Discuss the importance of isogonics map.
4. Assume that you are required to prepare the map of your college campus by plane table survey. Give the step by step procedure to be adopted.
5. Explain the different operations involved in working with plane table
6. State the 'three point problem' and explain 'Bessel's method' of solving the same.
7. The true bearing of a tower as observed from a station A is 350º 30', and the magnetic bearing of the tower is2º 30', the back bearing of the line AB when measured with a prismatic compass was found to be 330º What is the true bearing of the line AB?
8. What is local attraction? How would you detect it at a place? Explain the methods of determination of the correct bearings of lines of a traverse if some stations are suspected of local attraction.
9. The bearing of a line AB was found to be N 79º E. There was local attraction at A. In order to determine the correct bearing of the line, a point O was selected at which there was no local attraction. The bearing of the line AO was S 53º 45'E and that of OA was N 57º 30'W. Determine the correct bearing of the line AB.
10. The bearings of the lines of a closed traverse are 290º 30'; 50º 30; 196º 0; 175º30'; 112º 0'; 30º 0'; Determine the included angles and the angular error.
11. What are the different methods of plotting a compass traverse? Describe with the help of sketches.
12. Explain the Bow ditch rule for adjusting a compass traverse
13. What are different types of errors in a compass traverse? How can these be minimized?
14. What do you understand by closing error of a compass traverse? Show how it can be adjusted by graphical method.
15. Explain with neat sketch, the graduations of a prismatic compass and a surveyor's compass

16. Differences between prismatic compass and a surveyor's compass.

UNIT-III

1. What are the different types of leveling staff? State the merits and demerits of each.
2. Describe in detail profile leveling and cross-sectioning
3. Compare the rise and fall method of reducing leveling notes with height of collimation.
4. Discuss the effects of curvature and refraction in leveling
5. Explain what is meant by sensitiveness of a level tube? Describe how would you determine in the field the sensitiveness of a level tube attached to a dumpy level
6. What are the different sources of errors in leveling? How are they eliminated?
7. Explain the temporary adjustments for a dumpy level
8. Explain the special methods of spirit leveling
9. The following consecutive readings were taken with a level and 5 meter leveling staff an continuously sloping ground at a common interval of 20 meters. 0.385 ; 1.030 ; 1.925 ; 2.825 ; 3.730 ; 4.685 ; 0.625 ; 2.005 ; 3.1101 ; 4.485 the R.L of the first point was 208.125 m. Rule out a page of level book and enter the readings. Calculate the R.L.'S of the points by rise and fall method also the gradient of the line joining the first and last point.
10. List some of the difficulties encountered in leveling.
11. A series of ordinates were taken from a chain line to a curved boundary line at intervals of 15m in the following order. 0, 2.65, 3.80, 3.75, 4.65, 3.6, 4.95, 5.85m Compute the area between the chain line, the curved boundary and the end offsets by (i) average ordinate rule (ii) Simpson's rule (iii) trapezoidal rule.
12. What is a 'grand contour'? Describe how to locate it in the field?
13. The observation ray between two triangulation stations A and B just grazes the sea. If the heights of A and B are 9000 meters and 3000 meters respectively, determine approximately the distance AB. Assume the diameter of earth as 12,880 km
14. What are the different types of leveling instruments used in leveling? Bring out the essential differences between them and state which is the meet preferred why?
15. What do you understand by reciprocal leveling? When is the procedure adopted? Explain the concept with a sketch.
16. The Reduced levels of the ground at four points P, Q, R and S are 178.32, 178.15, 177.83 and 178.15m respectively. A deep pipe line is to be laid so that its invert is to be 10m below P at a gradient of 1 in 340 toss. The distances PQ, QR and RS are 117.6m, 264.9m, 441.9m. Find the invert levels and depths of trench at Q, R and S.
17. Explain, with a sketch and illustration, how you would find the available head room in a hall using a leveling instrument and a leveling staff.
18. What is the necessary to balance the sights during a fly leveling?

UNIT-IV

1. Explain how you would take field observations with a theodolite so as to eliminate the following verniers.
    a. Error due to eccentricity of verniers.
    b. Error due to non-adjustment of line of sight
    c. Error due to non-uniform graduations
    d. Error due to slip
    e. Index error of vertical circle.
2. Explain the temporary adjustments of a transit.
3. Explain how would you measure with a Theodolite
    a. vertical angle
    b. Horizontal angle by repetition
    c. Magnetic bearing of line.

d. What are the different errors in theodolite work? How are they eliminated?

4. State what errors are eliminated by repetition method. How will you set out a horizontal angle by method of repetition?
5. What is error of closure? How is it balanced graphically?
6. Describe fast needle method of theodolite traversing.
7. Explain clearly, with the help of illustrations, how a traverse is balanced.
8. What are 'face left' and 'face right' observations? Why is it necessary to take both these observations?
9. Write in detail about the following permanent adjustments.
    a. Adjustment for vertical axis
    b. Adjustment for line of collimation
    c. Adjustment for horizontal axis.
10. What is the various permanent adjustment of Theodolite? Explain in detail.
11. State the advantages of Tachometric surveying
12. Describe a theodolite with a neat sketch and explain how the vertical angles are measured using it.

UNIT- V

1. Explain the various methods of determining the length of a transition curve.
2. What are the difficulties in setting out simple curves? Describe briefly the methods employed in overcoming them.
3. A reverse curve AB is to be set out between two parallel tangents, 12m apart. If the two areas of the curve are to have the same radius. And the distance between the tangent points A and B is 96m, calculate the radius. The curve is to be set out from AB at 8m intervals along that line .Calculate the tangent offsets.
4. Write about the various elements of a simple circular curve.
5. Explain the method of setting out a simple curve by two theodolites.
6. Determine the offsets to be a set out at a chain interval along the tangents, to locate a 16 chain curve, using by radial offsets method, perpendicular offsets method and by approximate method.
7. Why to curves become necessary along highway alignment? Bring out the various classifications of highway curves.
8. A Simple circular curve is to have a radius of 573m. The tangents intersect at chain age 1060 m and the angle of intersection is 120 Find.
9. Tangent distance
10. Chain age at beginning and end of wave
11. Length of long chord
12. Degree of curve
13. Number of full and sub-chords.
14. Draw a simple circular curve and mark the salient points. Explain the setting out of curve by two theodolite method.
15. Briefly explain procedure for setting out a tunnel.
16. Briefly explain the different methods of adjusting a traverse.
17. With a neat sketch show the different parts of a simple circular curve.
18. What is a transition curve? Why this is used?
19. What is meant by 3-4-5 rule? How this is applied to a single roomed building?
20. Explain the elements of a compound circular curve.
21. Explain general requirements of a transition curve in detail.
22. Enumerate the classification of curves in engineering surveys.
23. Two straights intersect at a deflection angle of 80 and are connected by a circular curve of radius to chains. Find the length of 'each and tangent', the 'curve', and the 'long chord', the apex distance' the 'mid ordinate of the curve' and the degree of the curve.

24. How is a simple curve set out by using one theodolite and one chain?
25. Briefly explain ‘reverse curves’ and ‘shift of a transition curve’.
26. What are the various methods of setting out simple curves?