INSTITUTE OF REMOTE SENSING

ANNA UNIVERSITY, CHENNAI - 600 025.

LAB MANUAL

SURVEYING 2 LABORATORY

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Expt No. 1	STUDY OF THEODOLITE AND ANGLE OBSERVATIONS BY REPETITION	Date of Expt:

AIM:

To study about the different parts and working principle of theodolite and To measure the horizontal angle by repetition and reiteration methods.

APPARATUS REQUIRED:

- Tripod
- Theodolite
- Plum bob

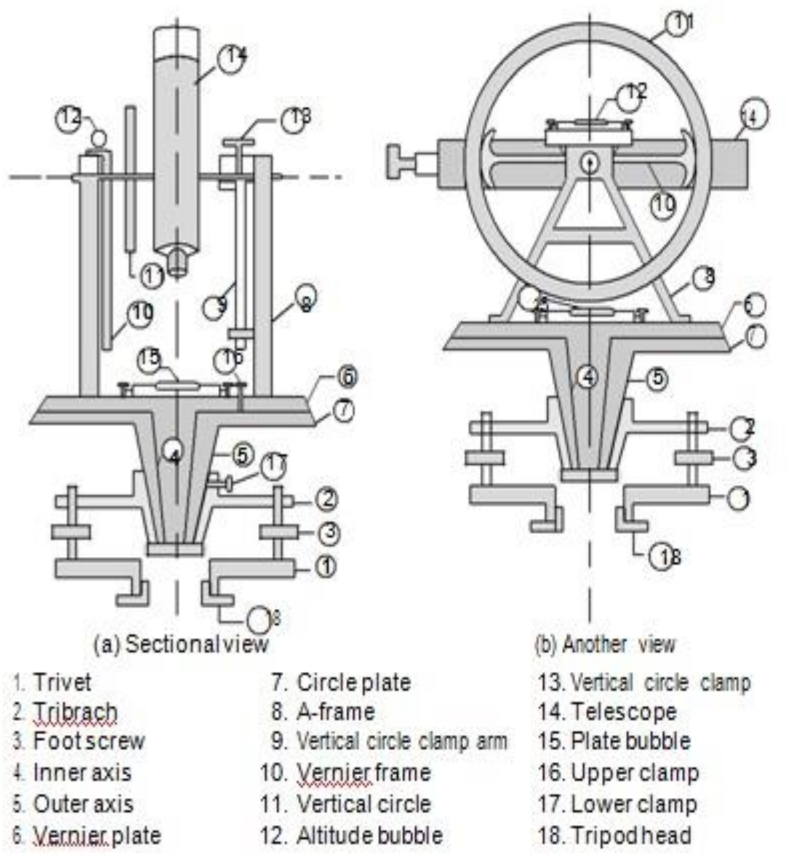


Fig1. Theodolite

PARTS OF TELESCOPE:

Fig.1 shows the parts of a vernier theodolite

Telescope

The telescope is an integral part of theodolite and mounted on a spindle known as horizontal axis. The more telescope are internal focusing. The essential parts of telescope are eye piece, diaphragm with cross basis, object lens and focus.

Optical Plummet

Optical plummet consist of an eyepiece set in the lower plats. The line of sight through the eye piece which is reflected vertically downward, beneath the instruments by means of a prism is precisely in line with the vertical axis.

Vertical Circle (scale)

Vertical circle is used to measure the angle between the line of sight of the telescope and the vertical axis.

Horizontal Scale (circle)

Horizontal scale is often placed between the upper and lower places. It is capable full independent location about the trunnion axis.

Upper plate

Upper plate is the base of which the standards and vertical circle are placed. For the instrument to be in correct adjustment it is necessary that the upper must be perpendicular to the alidade axis and parallel to the trunnion axis.

Lower plate

Lower plate is the base on the whole instrument. It houses the foot screws and bearing for the vertical axis. It is rigidly attached to the tripod mounting assembly and does not more.

The upper clamp screw

The upper clamp screw is a tangent screw used during a sequence (or) “round” of horizontal angle instrument.

The lower clamp screw

These must be used at the start of horizontal angle measurements to set the first reading to zero.

PROCUDURE:

SETTING – UP:

Centering the instrument over the station mark by a plumbob (or) by optical plummet and approximately leveling with the help of tripod legs, by moving the leg radially the plumbog is shifted in the direction of the leg while by moving the leg circumferentially (or) change in the inclination is effected without disturbing plumb bob.

LEVELLING:

The approximate leveling is done either with reference to a small circular bubble provided on tribrach is done by eye judgment. After having centered and approximately leveled the adjustment accurate leveling is done with the help as foot screws and with reference plate level.

FOCUSSING

To focus the eyepiece for distinct vision of the cross hairs paint the telescope towards the sky and more eye-piece in or out fill the cross hairs are seen sharp.The telescope is now directed towards the object to be sighted and focusing screw is turned till the image appears clear and sharp. The image so formed is in the plane of cross hairs.

METHOD OF REPETITION

Drawing

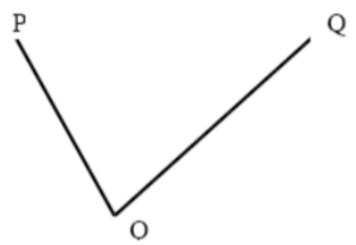


Fig.1 Method of Repetition

PROCEDURE

1. Set up the instrument over 'O' and level it accurately (Fig.1).
2. With the help of upper clamp and tangent screw, set 0º reading on vernier 'A'. Note the reading of vernier 'B'.
3. Release the upper clamp and direct the telescope approximately towards the point 'P'. Tighten the lower clamp and bisect point 'P' accurately by lower tangent screw.

4. Release the upper clamp and turn the instrument clock-wise towards Q. Clamp the upper clamp and bisect ‘Q’ accurately with the upper tangent screw. Note the readings of verniers ‘A’ and ‘B’ to get the values of the angle POQ.
5. Release the lower clamp and turn the telescope clockwise to sight P again. Bisect P by using the lower tangent screw.
6. Release the upper clamp, turn the telescope clockwise and sight Q. Bisect Q by using the upper tangent screw.
7. Repeat the process until the angle measured (required number of times is 3). The average angle with face left will be equal to final reading divided by three.
8. Change face and make three more repetitions as described above. Find the average angle with face right, by dividing the final reading by three.
9. The average horizontal angle is then obtained by taking the average of the two angles with face left and face right.

TABLE

Instrument At sighted to No of Repetition	Face Left			Face: Right			Average Horizontal angle
	A	B	Mean	A	B	Mean	

RE-ITERATION METHOD

Drawing

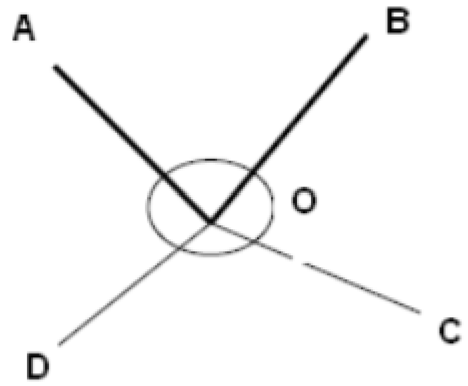


Fig.2 Method of Reiteration

PROCEDURE:

If it is required to measure angles AOB, BOC, and COD etc by reiteration method

The following steps are to be used.

1. Set the instrument over "O" and level it set the Vernier to zero and bisect point A accurately.

2. Loose the upper clamp and turn the Telescope clockwise to point B. Bisect B by using the upper tangent screw. Read both the Verniers, the mean of the Verniers will give the angles AOB.

3. Similarly, bisect successively C, D etc, thus closing the circle. Read both the Verniers at each bisection.

4. Finally sight to A the reading of the vernier should be the same as the original setting reading. Repeat the steps 02 to 04 with other face i.e. face Right.

RESULT:

Thus the parts and working principle of theodolite and the horizontal angle between the points are calculated

LAOB =

LBOC =

LCOD =

LDOA =

Expt No. 2	OBSERVATION OF ANGLES AND STATION ADJUSTMENT	Date of Expt:

2A i) MEASUREMENT OF HORIZONTAL ANGLE-REPETITION METHOD

AIM:

To determine the included angle between two object stations P and Q by using repetition method.

INSTRUMENTS REQUIRED:

- Theodolite
- Tripod

PROCEDURE:

1. Set the instrument at "S" approximately at the middle of the given objects to avoid too obtuse and too acute angles.

2. Do all initial adjustments with face left.

3. Rotate the upper plate clockwise or anticlockwise so that the zero mark of the "A" vernier scale coincides with the zero mark of the main scale. Similarly vernier "B" will read 180°. Now tight the upper clamp.

4. Loosen the lower clamp screw and direct the telescope towards the object P. See whether the vernier readings read 0º and 180" still.

5. Tighten the lower clamp and loosen the upper clamp, and bisect point Q accurately by lower tangent screw.

6. Note the readings of verniers A and B to get the horizontal angle of PSQ.

7. Loosen the lower clamp screw. Turn the upper plate clockwise to sight "P" again and bisect accurately by lower Tangent screw.

8. Repeat steps 5 to 8, until the angle is repeated to the required number of repetitions. (Usually 3).

9. Change the face to right, and set the vernier A to 180° to eliminate graduation error in horizontal circle and note the readings similarly as above.

TABLE:

Instrument At sighted to No of Repetition	Face: Left Swing:Right			Face: Right Swing:Right			Average Horizontal angle
	A	B	Mean	A	B	Mean	

RESULT:

Thus the horizontal angle between the points are calculated by repetition method.

2A. ii) MEASUREMENT OF THE HORIZONTAL ANGLE-REITERATION METHOD

AIM:

To determine the included angle between the given stations by reiteration method

INSTRUMENTS REQUIRED:

- Theodolite with stand
- Ranging rods
- Tape
- Plumb Bob

PROCEDURE:

1. Set the instrument over "S" which should be at the centre of the arrangement of the given objects.

2. Do all the initial adjustments and keep the vertical circle to right.

3. With face left, set vernier A to 0° and bisect the ground point 'A' and turn the telescope to object B by loosening the upper clamp.

4. In the same way bisect the other objects in clockwise direction and note down the readings. B C

5. Do the same procedure with the face right.

TABLE:

Instrument At sighted to No of Repetition	Face: Left Swing:Right			Face: Right Swing:Right			Average Horizontal angle
	A	B	Mean	A	B	Mean	

RESULT:

Thus the horizontal angle between the points are calculated by reiteration method.

2B. MEASUREMENT OF VERTICAL ANGLES

AIM:

To determine the vertical angles of the given objects.

INSTRUMENTS REQUIRED:

Theodolite with tripod, Plumb Bob

PROCEDURE:

1. Set up the instrument at any convenient place to cover all the given points.

2. Level the instrument with reference to the altitude bubble by using foot screws as in the case of horizontal bubble levelling.

3. Set the zero of the vernier "C" exactly in coincidence with the zero of the vertical scale.

4. Loosen the vertical plane until the focused object is bisected. Use tangent screw for accurate bisection.

5. Read both the verniers C and D of vertical circle.

6. Denote the elevation angle with +ve sign and depression angle with ve sign.

7. Similarly bisect all other objects and find out the readings accurately.

8. Change the face and follow the steps 4 to 6 above.

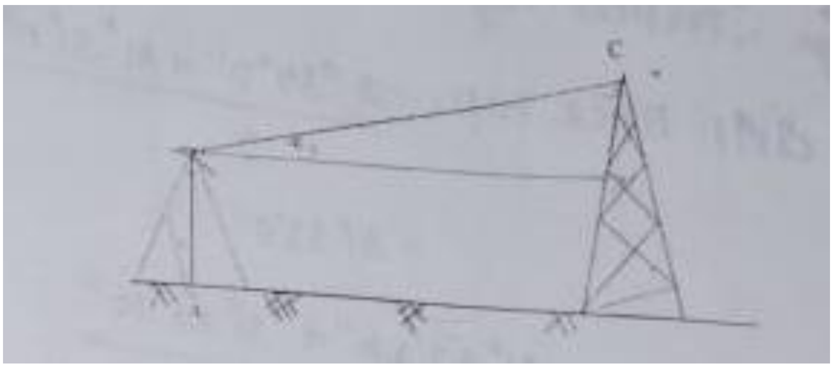


TABLE:

Instrument At sighted to No of Repetition	Face: Left Swing:Right			Face: Right Swing:Right			Average Vertical angle
	C	D	Mean	C	D	Mean	

RESULT:

Thus the angle between the points are calculated.

Expt No. 3	DETERMINATION OF COORDINATES OF INACCESSIBLE POINT(S)	Date of Expt:

AIM:

To determine the height of the building

APPARATUS REQUIRED:

- Theodolite
- Tripod
- Tape
- Arrows
- Levelling staff

FORMULA:

$H_1 = Dtand1$

$H_2 = (D+b)\ tand_2$

$$D = \frac{S+btanx_2}{tand_1 - tand_2}$$

$S = S_2 - S_1$

RL of Q = $BH + h_1 + S_1$ (or) $BM + h_2 + S_2$

D – Difference between object and the first instrument.

S – Difference between height of the two instrument.

HI – Height of the instrument (S_1-S_2)

BH – Bench Mark

h_1,h_2 – height of the tower measured by the instrument.

d1+d2 – direction angle measured.

PROCEDURE:

- Setup the instrument at station P.
- Perform all temporary adjustments.
- Bring the line of collimation horizontal
- Enter the initial readings in the tabular form.
- Swing the telescope and take staff reading over the given B.M.
- Swing the telescope towards the object
- Release the vertical clamp screw, sight the top of the object Q1, and clamp the vertical clamp screw.
- Read C and D verniers and enter the readings.
- Release the vertical clamp screw, sight the bottom of the object Q, and clamp the screw.
- Read vernier readings and enter in the tabular form.
- Measure the Horizontal distance between the instrument station and the object.
- The above procedure will be repeated with the face right observation.
- The average of the two observations by transiting the telescope taken with different faces will be vertical angle.
- Calculate the height of the top point Q1 from horizontal line (h1) and height of the bottom point Q0 from horizontal line (h2) by using formula h = d tan α

Methods:

1.Measurement of Height of an object when base is accessible (on level ground)

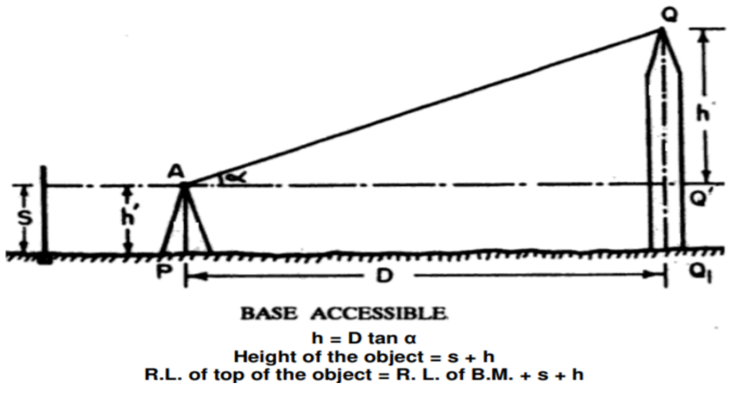
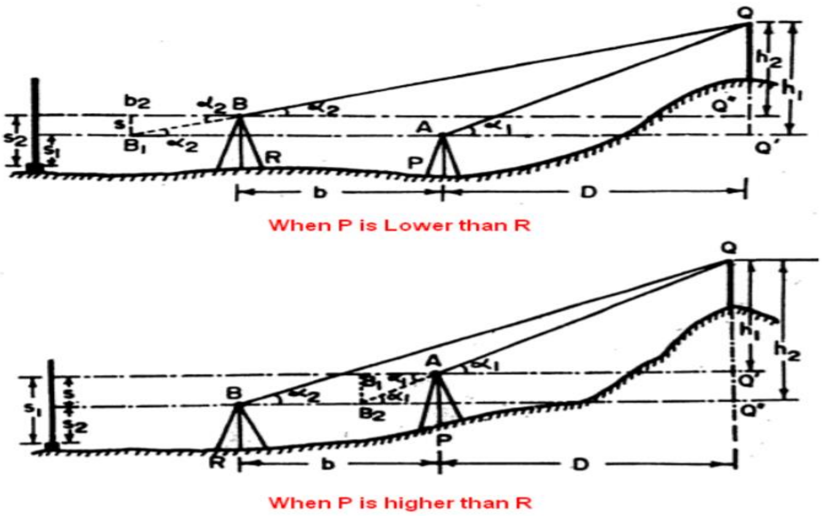


Fig.1 Base is accessible

2.Measurement of Height of an object when base is inaccessible (fig.2)



$$D = \frac{(b \pm s \cot \alpha_2) \tan \alpha_2}{\tan \alpha_1 - \tan \alpha_2}$$

Fig.2 Base is inaccessible (Single Plane Method)

TABLE

Instrument At sighted to No. of Repetition	Face Last		Suring: Right		Face: Right		--------	Right	Average
	A	B	Mean	Horizontal angle	A	B	Mean	Horizontal angle	Horizontal angle

RESULT:

The height of the object is

Expt No. 4	COMPUTATION OF AREA OF A TRIANGLE WITH ONE INACCESSIBLE POINT AND REDUCED LEVEL OF INACCESSIBLE POINT USING DOUBLE PLANE METHOD	Date of Expt:

AIM:

To determine the height of the object when the base of the object is inaccessible.

APPARATUS REQUIRED:

- Theodolite
- Tripod
- Arrows
- Tape
- Levelling staff

FORMULA:

Using sine rule

$$D_1 = \frac{b\sin Q_1}{\text{Qin}\ (Q_1+Q_2)}$$

$$D_2 = \frac{b\sin Q_2}{\text{Qin}\ (Q_1+Q_2)}$$

DRAWING

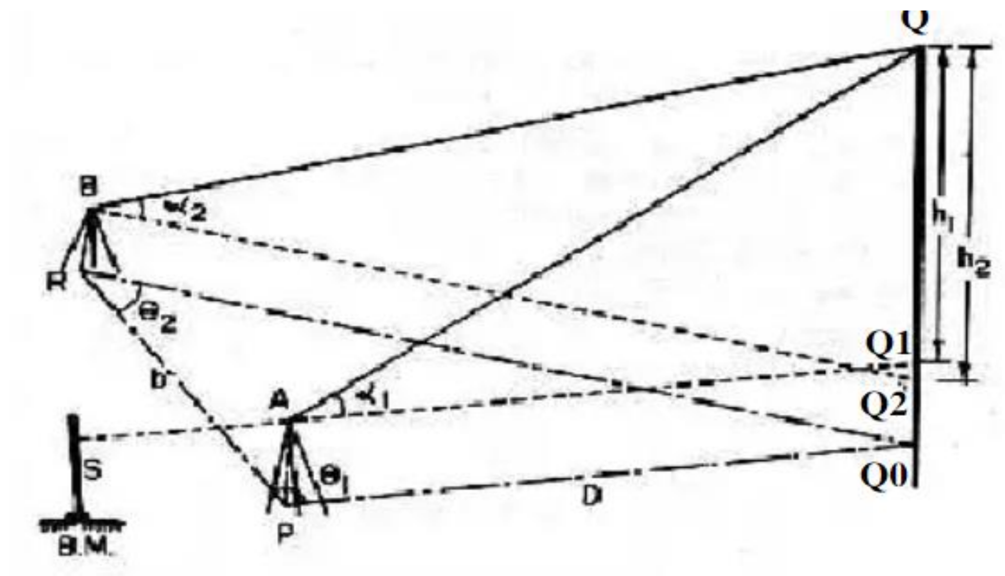


Fig.1 Base Inaccessible (Double Plane Method)

PROCEDURE:

Let P&R be the two instruments stations which are not in the same vertical plane as that of the elevated object 'Q' as shown in Fig.1 P&R are should be selected such that the triangle PQR is a well conditioned triangle.

It is required to find out the elevation of the top of an object 'Q'

1. Setup the instruments at P and level it accurately w.r.t. the altitude bubble. Bisect the point Q and measure the angle of elevation 'α_1'.
2. Sight to point R with reading on horizontal circle as zero and measure the horizontal angle RPQ1 (θ_1) from P.
3. Take a back sight 'S' on the staff kept at A.B.M.
4. Shift the instrument to R and measure 'α_2'and 'θ_2' from R.
5. Measure the distance b/w two instrument stations R & P (equals to 'b')

RESULT:

The height of the tower is _________.

Expt No. 5	COMPUTATION OF FILLING VOLUME FOR A TRIANGULAR LAND USING TANGENTIAL TACHEOMETRY	Date of Expt:

AIM:

To determine the elevation of an inaccessible point when both angles are in elevation / depression by tangential tacheometric surveying.

INSTRUMENTS REQUIRED:

- Theodolite
- Tape
- Cross staff
- Arrows
- Tripod

PRINCIPLE

The Tacheometer is an instrument which is generally used to determine the horizontal as well as vertical distance. It can also be used to determine the elevation of various points which cannot be determine by ordinary leveling. When one of the sight is horizontal and staff held vertical then the RLs of staff station can be determined as we determine in ordinary leveling .But if the staff station is below or above the line of collimation then the elevation or depression of such point can be determined by calculating vertical distances from instrument axis to the central hair reading and taking the angle of elevation or depression made by line of sight to the instrument made by line of sight to the instrument axis.

OBSERVATIONS AND CALCULATIONS:

P = position of the instrument

Q = staff station

M = position of instrument axis A,

B = position of vanes

S = distance between the vanes (staff intercept)

$\alpha 1$ = angle of elevation corresponding to A

$\alpha 2$ = angle of elevation corresponding to B

D = horizontal distance between P and Q = MQl

V = vertical intercept between the lower vane and the horizontal line of sight

h = height of the instrument of MP

r = height of the lower vane above the foot of the staff = staff reading at lower vane = BQ

a.Angles of Elevation

From triangle MBQ^{l}, $V = D \tan\alpha_2$

From triangle AMQ^{l}, $V+s = D \tan\alpha_1$

$S = D \tan\alpha_1 - D \tan\alpha_2$

$$D = \frac{s}{\tan\alpha 1 - \tan\alpha 2} = \frac{s \cos\alpha 1 \cos\alpha}{\sin(\alpha 1 - \alpha 2)}$$

$$V = D \tan\alpha_2 = \frac{s \tan\alpha 2}{\tan\alpha 1 - \tan\alpha 2} = \frac{s \cos\alpha 1 \sin\alpha 2}{\sin(\alpha 1 - \alpha 2)}$$

Elevation of Q = (Elevation of station + h) + V – r

b.Angles of Depression

Observations and Calculations:

With the same notations as earlier

$V = D \tan\alpha_2$ ....(1)

$V\text{-}s = D \tan\alpha_1$ ....(2)

Subtracting (2) from (1), we get

$S = D \tan\alpha_2 - D \tan\alpha_1$

$$D = \frac{s}{\tan\alpha 2 - \tan\alpha 1} = \frac{s \cos\alpha 1 \cos\alpha 2}{\sin(\alpha 2 - \alpha 1)}$$

$$V = D \tan\alpha_2 = \frac{s \tan\alpha 2}{\tan\alpha 2 - \tan\alpha 1} = \frac{s \cos\alpha 1 \sin\alpha}{\sin(\alpha 2 - \alpha 1)}$$

Elevation of Q = (Elevation of station + h) - V - r

PROCEDURE

1. Set up the instrument at P and level it accurately by carryout the temporary adjustments (Fig.1 and Fig.2).
2. Set vernier reading to zero making line of sight horizontal.
3. Take the first staff reading on Benchmark and determine height of instrument and let it be h.
4. Then sight the telescope towards the staff station whose R.Ls are to be calculated.
5. Measure the angle on vernier if line of sight is inclined upward or downward and also note the three crosshair readings.
6. Determine the R.Ls of various points by calculating the vertical distance

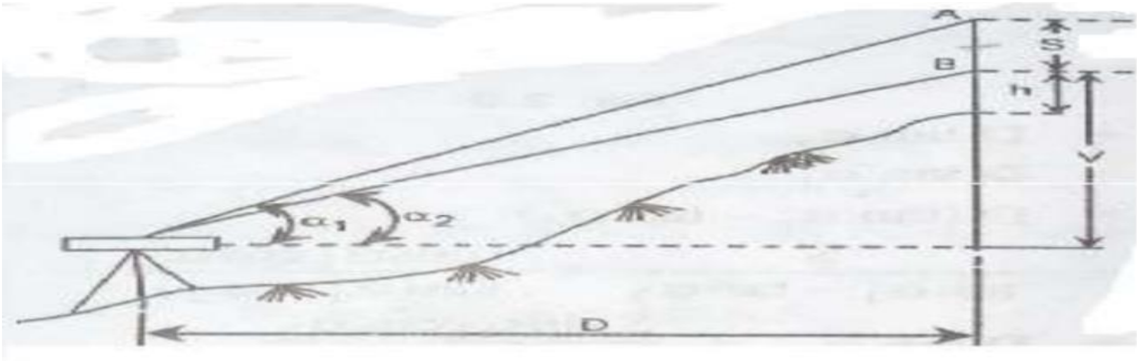


Fig.1 Heights and distance using principles of tacheometric surveying – when both angles are in elevation

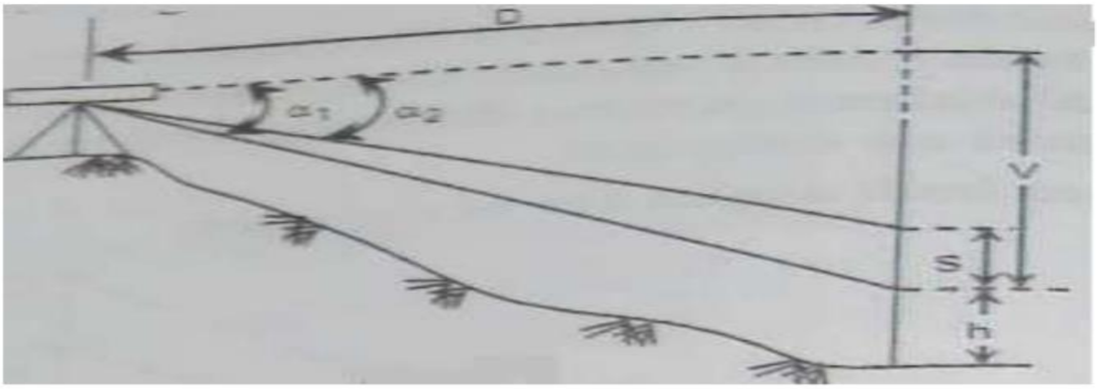


Fig.2 Heights and distance using principles of tacheometric surveying – when both angles are in depression

RESULT:

The elevation of the inaccessible point is __________.

Expt No. 6	PREPARATION OF PLANIMETRIC MAP USING STADIA TACHEOMETRY	Date of Expt:

AIM:

To determine the height of the object when the line of sight is inclined and the object in held vertically.

APPARATUS REQUIRED

- Theodolite
- Tripod
- Tape
- Levelling staff

FORMULAE

P = Instrument Station

Q = Required Height of that point

$D = f/i \times S COS^2 Q + (f+d) COSQ$

$V = f/i \times SCOSQ \, SINQ + (f+d) \sin Q$

RL of Q = $BH + HI + (v-y_2)$

PROCEDURE

1. Place the instrument at a point O and fix the leveling staff at P(Fig.1).
2. After place the instrument at a point O and do the temporary adjustment (Centering, Levelling and Focussing)
3. Focus the levelling staff at any point and note down the upper, middle and lower hair readings.
4. Measure the vertical angle at that point.
5. Find the height of the instrument using tape.
6. Then using the formula, height of the point in the station distance between the instrument station to the leveling staff and RL of P is calculated

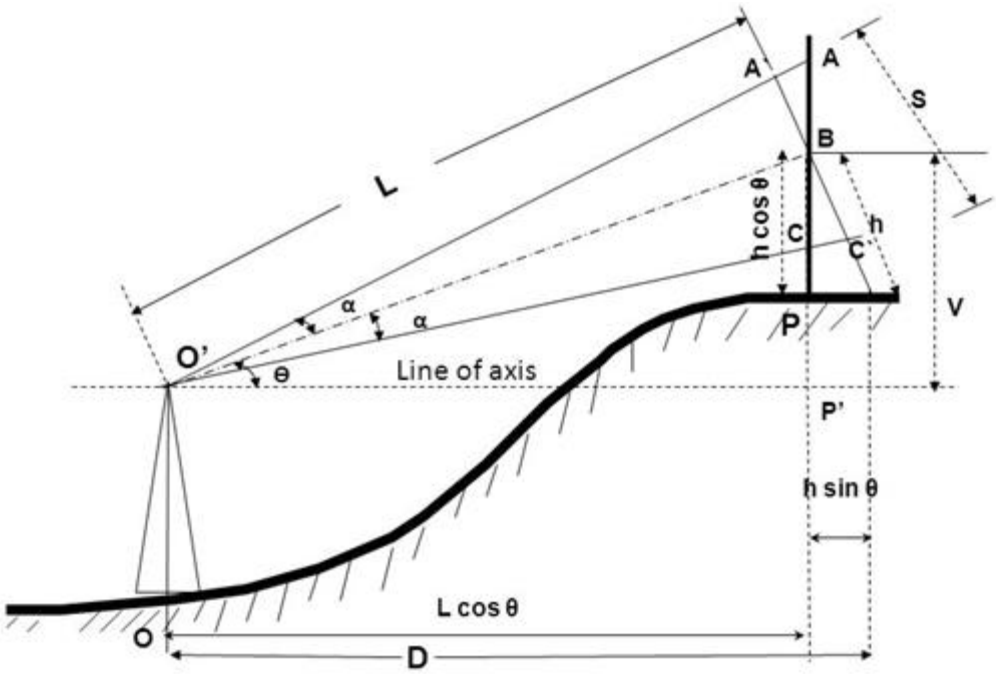


Fig.1 Stadia Tacheometry – inclined line of sight and staff held vertical

RESULT:

The elevation of the point P is

Expt No. 7	ESTABLISHMENT OF BASELINE (ESTABLISHMENT OF NEW BASELINE USING ANGLE MEASUREMENTS TO EXISTING BASELINE)	Date of Expt:

AIM:

To establish a new baseline by measuring angles between points, relative to an existing baseline. This is a fundamental task in surveying and geodesy, commonly used for triangulation and other forms of distance and position determination.

MATERIALS REQUIRED:

- Theodolite or Total Station
- Surveying Tripod
- Measuring Tape or Electronic Distance Measuring (EDM) Device
- Surveying Rods or Reflectors
- Plumb Bobs or Leveling Instruments
- Field Notebook or Data Recording Sheet

THEORY:

Baseline:

A baseline is a known reference line of measured distance used in triangulation or geodetic measurements. It's essential that the distance between two points (A and B) is accurately known, as it serves as the reference for further measurements.

Angle Measurement:

In this method, the angles between known reference points (e.g., the existing baseline) and new points are measured using an instrument like a theodolite. Using these angle measurements along with known baseline distance, the coordinates of the new points can be determined.

PROCEDURE:

Setup of the Existing Baseline:

- Set up the theodolite or total station at one end of the existing baseline (Point A).

- Measure the distance between Points A and B, and record it in the field notebook.
- Ensure that both points are clearly visible to each other and the theodolite.

Establishing the New Baseline (New Line X-Y):

- Select two points (C and D) where you would like to establish the new baseline. These points should ideally form a triangle with the existing baseline.
- Position the theodolite at Point A and measure the angle between the existing baseline (Point A to B) and the new baseline (Point A to C).
- Move the theodolite to Point B and measure the angle between the baseline (Point B to A) and the new baseline (Point B to D).
- Record the measured angles (let's say ∠CAB and ∠DBA).

Angle Measurements for Further Points:

- From Points C and D, use the theodolite to measure the angles to the reference baseline (A-B). This will allow you to establish the relative positions of points C and D with respect to the existing baseline.

Calculation of Coordinates:

- Using the known baseline distance and the measured angles, apply triangulation principles to calculate the coordinates of Points C and D.
- Use trigonometric formulas (such as the Law of Sines or Cosines) to calculate the distances or use a software package designed for surveying (e.g., AutoCAD or ArcGIS) to perform the calculations.

Verification:

- Check your measurements for consistency by performing additional angle and distance measurements, if possible.
- Confirm that the newly established baseline is correctly aligned with the reference baseline, ensuring the accuracy of the new baseline.

Data Recording:

- Record all angle measurements, distance calculations, and the coordinates of new points in your field notebook or survey software.

- Document the weather conditions, instrument calibration, and any other observations that might affect the measurement accuracy.

RESULT:

This exercise demonstrates how to use angle measurement techniques to establish a new baseline relative to an existing baseline. Mastery of this method is crucial for conducting precise surveys and geodetic measurements.

Expt No. 8	ESTABLISHMENT OF HORIZONTAL CONTROL POINTS BY TRAVERSING	Date of Expt:

AIM:

To draw the accurate travels with the help of independent coordinates of theodolite traverse by applying necessary corrections to the consecutive coordinates of the same Travels and to find the area of the traverse.

APPARATUS REQUIRED:

- Theodolite
- Tripod
- Ranging rod
- Arrow
- Tape

OBJECTIVE:

- It is effectively used to reduce the error of closure to zero.
- Algebraic sum of latitude and departure becomes zero when the total area of traverse is distributed among various sides of traverse so that the traverse figure actually closes geometrically.

PROCEDURE:

A. Traversing procedure:

- Set up the instrument over the sorting point a and perform temporary adjustment.
- Observe the bearing of line AB using compass.
- Set the vernier scale regarding to zero and side the previous station point e loosening the lower clamp exact bisection can be done by tightening the lower clamp and adjusting the lower at tangent screw.
- Release the upper clamp and swing the telescope in clockwise direction to right to the next station point B read both vernier A and B mean of this vernier readings give included angle EAB.
- Shift the instrument to the next station point B and repeat the above two steps 2 and 3 to obtain included angle ABC.
- The above procedure is repeated at all the other station points to observe the respected include angle.
- The length of lines AB,BC,CD,DE and EA are measured using tape.

B. Gale's table procedure:

- Adjust the interior angles to satisfy the geometrical conditions i.e sum of interior angles to be equal to (2N-4)*right angles and exterior angles (2N+4)*right angle. In the case of compass traverse the bearings are adjusted for the local attraction.
- starting with observed bearings of one line calculate the bearings of all other lines reduce all bearings to quadrilateral system.
- calculate the consecutive co-ordinate i.e is latitude and depression.
- Calculate ΣL and ΣD.
- Apply necessary correction to the latitude and departure of the line ΣL and ΣD are equal to 0 so that the corrections may be applied either by transit rule or compass tool depending upon the traverse.
- Using the corrected consecutive coordinates calculate the independent coordinates to the point so that they are all positive the whole of the traverse thus lying in the north east quadrant.

OBSERVATION:

TABLE:

ANGLE	SWING LEFT			SWING RIGHT			MEAN
	Ver A	Ver B	Mean	Ver A	Ver B	Mean	

RESULT:

The area of the closed traverse ABCDEA formed is found to be

Expt No. 9	MAPPING OF TOPOGRAPHIC FEATURES INCLUDING A COMPLETE BUILDING USING CONTROL POINTS (USING CONTROL POINTS ESTABLISHED, VARIOUS TOPOGRAPHIC FEATURES ARE TO BE MAPPED)	Date of Expt:

AIM:

To map topographic features, including a building, using control points as a reference.

To understand the application of control points in mapping and how to integrate them for creating accurate topographic maps.

INSTRUMENTS REQUIRED:

- Total station, theodolite, or GNSS (GPS) receiver
- Tripods and surveying rods
- Measuring tapes or electronic distance measuring (EDM) devices
- Notebook or data logger for recording measurements
- Computer software for mapping and analysis (e.g., AutoCAD, GIS software)
- Control points with known coordinates (e.g., in the form of surveyed benchmarks)

THEORY:

Control Points:

Control points are precisely measured locations on the ground with known coordinates. These serve as reference points for surveying and mapping. In this exercise, control points will help accurately map the location of topographic features, including buildings, roads, vegetation, and other natural or man-made structures.

Topographic Mapping:

Topographic maps represent the 3D features of the terrain, including natural and man-made features, with contours or elevation data. The exercise involves using horizontal and vertical control to accurately position and map these features.

Surveying Equipment:

Common tools used include theodolites, total stations, GPS devices, or total station/RTK systems. These tools help measure horizontal distances, angles, and elevations to establish accurate coordinates for each feature being mapped.

PROCEDURE:

1. Preparation and Setup:

1.1 Identify Control Points:

Choose at least three well-established control points (station points with known coordinates) that will act as references for your mapping project. The control points should be distributed in a way that ensures accurate triangulation or trilateration.

1.2 Set Up Equipment:

Set up the total station, theodolite, or GNSS receiver at a location where it can clearly observe the control points and the area to be mapped.

Ensure the equipment is calibrated properly and aligned with the control points.

1.3 Mark the Boundaries of the Mapping Area:

Survey the perimeter of the building or the area to be mapped and identify significant features (e.g., corners, boundaries, and edges).

2. Mapping the Building and Topographic Features:

2.1 Measure Horizontal and Vertical Angles:

For each significant point (e.g., corners of the building, edges of roads, trees, fences), measure the horizontal angles using the total station or theodolite.

Measure the vertical angles if height data is required, or use a leveling instrument to determine elevations for each point.

2.2 Measure Distances:

Measure the horizontal distances from the instrument to each topographic feature using either direct measurement with a tape or electronic distance measuring (EDM) devices.

For high accuracy, consider using a total station or GNSS equipment that can also capture elevation (3D coordinates).

2.3 Data Recording:

Record all measurements in a systematic manner. This includes the distance, angle, and reference coordinates for each feature being mapped.

For complex features like a building, take measurements at different key points such as corners, doorways, windows, and rooflines.

3. Data Processing:

3.1 Coordinate Computation:

Once all the measurements are recorded, use the known control points to convert the distance and angle measurements into actual coordinates (X, Y, Z) for each surveyed point.

Apply triangulation or trilateration techniques to determine the precise locations of the features relative to the control points.

3.2 Plotting the Topographic Map:

- Use software such as AutoCAD, GIS, or other mapping tools to plot the surveyed points and create a topographic map.
- For buildings, input the corner and boundary points, and connect them to form a complete outline of the structure.
- Include additional features like roads, trees, utility lines, or any other relevant topographic elements.

3.3 Create Contours (if applicable):

If elevation data is available, generate contours to show changes in the terrain height. These can be derived from the vertical measurements taken at different survey points.

4. Finalizing the Map:

4.1 Label Features:

Label all topographic features, including the building, roads, vegetation, and other structures, with appropriate symbols and annotations on the map.

4.2 Verify Accuracy:

Double-check the coordinates and measurements to ensure that the map is consistent with the control points. If discrepancies are found, investigate the source of error (e.g., instrument calibration, human error in measurement).

4.3 Review and Interpretation:

Analyze the final topographic map for its completeness and accuracy. Discuss how it could be used for future planning, construction, or other purposes (e.g., urban development, landscaping).

Sample Calculation:

Assume control points at locations $(X_1, Y_1, Z_1) = (500, 1000, 50)$, $(X_2, Y_2, Z_2) = (550, 1000, 52)$, and $(X_3, Y_3, Z_3) = (500, 1050, 51)$.

Measure angles and distances from a central station to various features (e.g., corners of the building, trees, etc.).

Use the total station or GNSS device to calculate the (X, Y, Z) coordinates for each feature.

Expected Results:

A detailed topographic map that includes the building and other mapped features (roads, vegetation, etc.).

Accurate coordinates (X, Y, Z) for each point on the map, referenced to control points.

RESULT:

- The exercise demonstrates the importance of control points in creating accurate topographic maps.
- The precision of mapping depends on the quality of the control points and the surveying equipment used.
- Understanding how to map topographic features is essential in applications such as construction, urban planning, and land surveying.

Expt No. 10	PREPARATION OF CONTOUR MAP	Date of Expt:

AIM:

To prepare a contour map by using the method of grid levelling.

INSTRUMENTS REQUIRED:

- Theodolite
- Tripod
- Ranging rod
- Arrow
- Levelling staffs

OBJECTIVE:

- Squares or grid method is suitable for contouring of plains or gently sloping grounds.
- It is used to identify any noticeable difference in elevation of the existing land.
- It is mainly used to visualize the nature of ground along a cross section of interest.

PROCEDURE:

- First, ensure that an appropriate BM is available near the size of the survey. If a BM is not available then one should be located near the site by fly leveling.
- Once a BM is available set up the instrument at a suitable position covering a large part of the area to be surveyed.
- The area is divided into number of squares and all the grid points are marked. Commonly used size of square is 2m*2m
- Take the back sight reading by sighting the BM.
- Levels of all grid points are established.
- Then the grid square is plotted on the graph sheet.
- Reduced levels of grid points are marked and contour lines are drawn by interpolation.

RESULT:

Thus the contour map using grid levelling is prepared with intervals of ________.

Expt No. 11	ESTIMATION OF SUN RISE/ SUN SET USING SUN OBSERVATIONS AND UNDERSTANDING OF NAUTICAL ALMANAC	Date of Expt:

AIM:

To determine the time of sun rise / sun set of the given location

PROCEDURE :

1. Set the instrument over the station mark and levelling very accurately.
2. Turn to the sun and observe and altitude and horizontal angle with the sun in quadrant 1 of the cross hair system (Fig.1). The motion in the azimuth is slow and the vertical hair is kept in contact by the upper tangent screw, the sun being allowed to make contact with the horizontal hair the line of observation is also noted.
3. Using two tangential screw as quickly as possible, bring the sun in to the quadrant 3 (Fig.1) of the cross hairs and again read the horizontal and vertical angles. Observe also the chronometer time. Take two more observations of the sun precisely in the same way as in steps 2 and 3 above, but this time with the sun is quadrant 2 and 4 (Fig.1). Note the time of each observations. The time of the two observations should not exceed 2minutes 8 seconds.
4. Take minimum 8 sets of readings.
5. Calculate the average vertical angle.
6. Plot the time Vs vertical angle and draw the best fit curve.
7. Extent the best fit curve till it cut the vertical angle at 0°

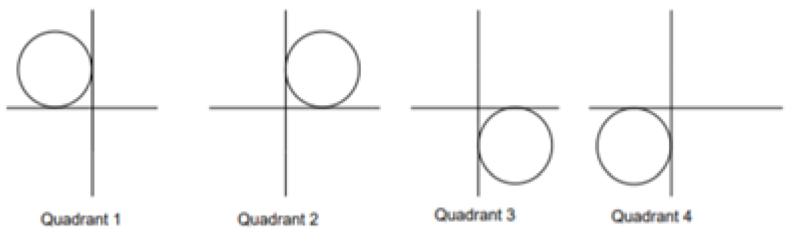


Fig.1 Ex-meridian observation of sun

Tabular Column

Inst at	Sight to	Ver C			Ver D		Mean			Note
		°	‘	“	‘	“	°	‘	“	
O	RM	0	0	0	0	0	0	0	0	
	Sun									1st Quadrant
	Sun									3rd Quadrant
Observed altitude(α’)										

Inst at	Sight to	Ver C			Ver D		Mean			Note
		°	‘	“	‘	“	°	‘	“	
O	RM	0	0	0	0	0	0	0	0	
	Sun									2nd Quadrant
	Sun									4th Quadrant
Observed altitude(α’)										

RESULT:

The time of Sun rise / sun set of the given place

Expt No. 12	COMPUTATION OF COORDINATES OF SELECTED STATIONS USING TRUE BEARING OF REFERENCE LINE (CALCULATION OF AZIMUTH OF REFERENCE LINE BY EXTRA-MERIDIAN OBSERVATIONS AND COMPUTATION OF COORDINATES FOR SELECTED STATIONS USING DISTANCE, ANGLE MEASUREMENTS)	Date of Expt:

AIM:

- To calculate the azimuth of a reference line using extra meridian observations.
- To compute the coordinates of selected stations based on distance and angle measurements.

THEORY:

Azimuth Calculation:

The azimuth of a reference line is the angle between the line and a fixed meridian (usually the north direction), measured clockwise. In surveying, extra meridian observations refer to angular measurements made relative to a known reference line at a different position in the survey network.

Coordinate Computation:

Using distance and angular measurements between stations, the coordinates of each station can be computed relative to a known reference point or coordinate system. The basic principles involve the use of trigonometry and coordinate transformations.

MATERIALS REQUIRED:

- Theodolite or total station
- Measuring tape or electronic distance measuring (EDM) device
- Survey station coordinates (for reference station)
- Angle measurements between stations
- Distance measurements between stations

- Calculator or computer software for computations (e.g., Excel, GeoGebra)

PROCEDURE:

1. Azimuth Calculation:

1.1 Set Up Survey Stations:

- Set up the total station or theodolite at a known station (reference point).
- Identify and mark the reference line (e.g., between two known stations).

1.2 Make Extra Meridian Observations:

Measure the angles from the reference station to the surrounding stations, taking note of their directions (clockwise or counter clockwise) with respect to the reference line.

1.3 Compute the Azimuth:

Use the following formula for azimuth calculation:

Azimuth = Measured Angle + Known Azimuth of Reference Line

If the angle measurement is made in the opposite direction, adjust the azimuth accordingly (subtract or add 180°).

2. Coordinate Computation:

2.1 Input Known Coordinates:

Input the coordinates of a reference station (e.g., Station A) from a reliable source (e.g., GPS, map).

2.2 Measure Distances and Angles:

Measure the distances (d) and angles (α) between the reference station and the selected stations (e.g., Stations B, C, etc.).

2.3 Apply Trigonometric Relations:

For each station, calculate the new coordinates using the following relations:

In a Cartesian coordinate system (X, Y):

$$X2 = X1 + d \cdot \cos(\alpha)$$

$$Y2 = Y1 + d \cdot \sin(\alpha)$$

Repeat for all stations using their respective distance and angle measurements.

2.4 Adjust for Azimuth:

If you calculated the azimuth, adjust the angles based on the reference line's azimuth before applying the trigonometric formulas.

3. Final Computation:

Once the coordinates for all selected stations have been calculated, compare the results with known coordinates (if available) to verify the accuracy of the measurements.

4. Analysis:

Discuss the potential sources of error, such as instrument calibration, human error in reading angles, or environmental factors.

Analyze how the accuracy of distance and angle measurements impacts the final coordinate calculations.

Sample Calculation:

Assume a reference station (A) with coordinates (X_1, Y_1) = (500, 1000) m.
Measure the distance (d) from A to station B as 200 m and the angle (α) from A to B as 30° east of north.
Calculate the coordinates of station B using the formulas:

$$X2 = 500 + 200 \times \cos(30^\circ)$$

$$Y2 = 1000 + 200 \times \sin(30^\circ)$$

Expected Results:

- The azimuth of the reference line.
- The computed coordinates of selected stations.

RESULT:

- The accuracy of the azimuth and coordinates depends on the precision of the angle and distance measurements.
- This experiment helps in understanding the practical application of surveying principles, including angular measurements and trigonometric computations for determining positions in a surveying network.

Expt No. 13	DETERMINATION OF MAGNETIC DECLINATION AT A STATION USING TRUE BEARING FROM HOUR ANGLE METHOD (COMPARISON OF MAGNETIC AND TRUE BEARING OF LINE DETERMINED USING HOUR ANGLE METHOD)	Date of Expt:

AIM:

The objective of this laboratory exercise is to determine and compare the magnetic bearing and true bearing of a line using the hour angle method for celestial navigation. To calculate the true bearing based on the position of a celestial body and then apply the local magnetic declination to obtain the corresponding magnetic bearing.

MATERIALS REQUIRED:

- Theodolite/Compass for measuring angles
- Celestial Navigation Tables (to obtain Hour Angle and Declination of a celestial body).
- Calculator (scientific or graphing).
- Magnetic Compass (for measuring magnetic bearing).
- Chart or Map of the observation area (to determine latitude and longitude).
- Magnetic Declination Chart (to obtain local magnetic declination).
- A Celestial Body (e.g., the Sun or a Star).

THEORY:

- True Bearing is the angle between a line (usually from the observer's position to a celestial body) and true north, which is defined by the Earth's rotation axis.
- Magnetic Bearing is the angle between the same line and magnetic north, which varies depending on the local magnetic declination.
- The Hour Angle Method involves calculating the true bearing of a celestial object (e.g., the Sun or a star) using its Hour Angle and Declination relative to the observer's position (latitude and longitude).

PROCEDURE:

Preparation:

- Determine the latitude and longitude of your observation location. This will be required for calculating the true bearing.
- Identify the celestial body to be observed (e.g., the Sun or a star). Record the declination and the hour angle of the celestial body at the time of observation.
- Obtain the local magnetic declination from a chart or map for the observation location.

Using the Hour Angle Method:

- For the celestial body being observed, use the hour angle method to determine the true bearing:
- Use the hour angle (H), declination (δ), and observer's latitude (ϕ) to calculate the true bearing using the formula:

$$\boldsymbol{\theta}\textbf{true} = \textbf{Arctan} \frac{\sin(H)}{\cos(H)\cdot\sin(\varphi)-\tan(\delta)\cdot\cos(\varphi)}$$

Where:

θtrue = True bearing

H = Hour angle

φ = Latitude of the observer

δ = Declination of the celestial body

- Calculate the true bearing of the line using the formula above.

Measure the Magnetic Bearing:

Use a magnetic compass to measure the magnetic bearing of the same line to the celestial body.

Apply the Magnetic Declination:

- Adjust the magnetic bearing to the true bearing by applying the magnetic declination (if positive, add; if negative, subtract).

θmagnetic =θtrue+Magnetic Declination

- Record the magnetic bearing.

Comparison:

- Compare the calculated true bearing and measured magnetic bearing.
- Note the difference between the two bearings and relate it to the magnetic declination value for the area.

Data Recording:

A.Location Information:

- Latitude of observation point: ____

- Longitude of observation point: ____

- Time of observation: ____

B. Celestial Body Information:

- Name of Celestial Body: ____
- Declination (δ) at the time of observation: ____
- Hour Angle (H) at the time of observation: ____
- Magnetic Declination at observation point: ____

C.True Bearing Calculation:

θtrue = ____°

D.Magnetic Bearing Measurement:

Measured magnetic bearing: ____°

Calculated Magnetic Bearing (adjusted for declination):

θmagnetic = ____°

Analysis and Discussion:

D.Compare the two bearings:

Discuss the difference between the true bearing and magnetic bearing.

How does the magnetic declination affect the magnetic bearing relative to the true bearing?

E.Accuracy of Measurements:

Evaluate the accuracy of the magnetic bearing measurement using the compass.

Discuss potential sources of error in both true bearing calculations and magnetic bearing measurements (e.g., errors in determining the hour angle, local magnetic anomalies).

RESULT:

Thus how celestial navigation and compass-based navigation are interrelated, helping us to understand the difference between magnetic and true bearings and how to adjust between them using the hour angle method.

Expt No. 14	SETTING OUT SIMPLE ROAD CURVE BY LINEAR METHOD (DEGREE OF CURVE : 1 - 20 DEGREES)	Date of Expt:

AIM:

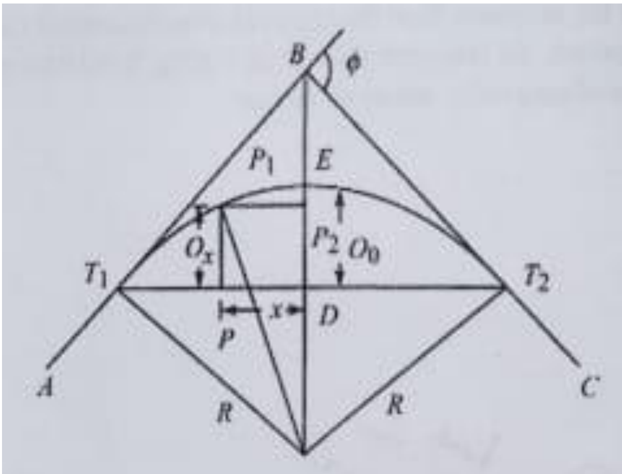
To set out the simple curve by linear method- method of offsets from long chord

INSTRUMENTS REQUIRED:

- Theodolite
- Ranging rods
- Chain
- Arrows
- Pegs

PROCEDURE:

- Calculate the datas necessary for setting out the curve.
- The tangent length is calculated from usual formula, and the points T1 and T2 are marked on the ground with pegs.
- The ordinates are calculated for the left half at some regular intervals. Points 1, 2, 3 and 4 are marked with pegs along the long chord.
- Ordinates 01, 02, 03, and 04 are calculated using usual formula.
- Set up a theodolite over T_1. Direct the telescope to bisect the point of intersection (B), with both plates clamped to zero.
- Perpendiculars are set out at points 1, 2, 3 and 4. The calculated ordinates 01, 02, 03, and 04 identified along these perpendiculars and points P1, P2, P3 and P4 are marked with pegs.
- Similarly the right half is made.



RESULT:

The given simple curve is thus set out.

Expt No. 15	SETTING OUT SIMPLE RAILWAY CURVE BY INSTRUMENT METHOD (DEGREE OF CURVE : 1 – 5 DEGREES)	Date of Expt:

AIM:

To set out the simple curve by single theodolite method.

INSTRUMENTS REQUIRED:

- Theodolite
- Ranging rods
- Chain
- Arrows
- Pegs

PRINCIPLE:

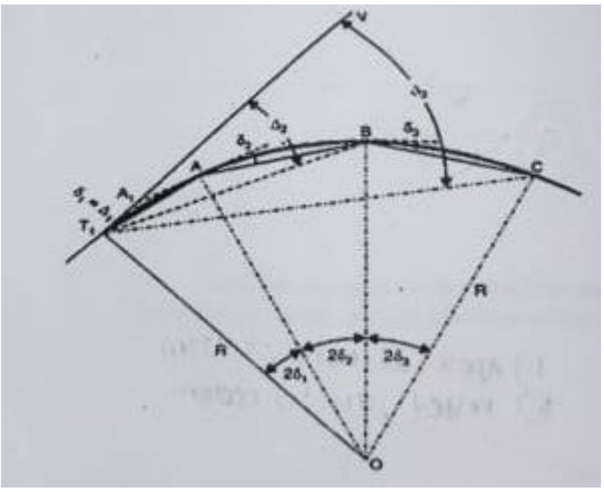
Deflection angle:

The angle between the back tangent and the chord joining the point of commencement of the curve and the other point on the curve

PROCEDURE:

- Calculate the datas necessary for setting out the curve.
- The tangent length is calculated from usual formula, and the points T1 and T2 are marked on the ground with pegs.
- The ordinates are calculated for the left half at some regular intervals. Points 1, 2, 3 and 4 are marked with pegs along the long chord.
- Ordinates 01, 02, 03, and 04 are calculated using usual formula.
- Set up a theodolite over T_1. Direct the telescope to bisect the point of intersection (B), with both plates clamped to zero.
- Perpendiculars are set out at points 1, 2, 3 and 4. The calculated ordinates 01, 02, 03, and 04 identified along these perpendiculars and points P1, P2, P3 and P4 are marked with pegs.
- Similarly the right half is made.
- Prepare a table of deflection angles for the first sub chord, normal chord and last sub chord.
- Set up a theodolite over T1 Direct the telescope to bisect the point of intersection (B), with both plates clamped to zero.
- Release the vernier plate and set angle 1 on the vernier.
- Point the zero end of the tape at T1 and an arrow held at a distance C1 along it and swing the tape around T1 till the arrow is bisected by the cross hairs to fix point A.
- Set the deflection angle.

- With zero end of the tape pinned at A and an arrow held at distance AB = C2 along it and swing the tape around A till the arrow is bisected by the cross hairs thus fixing the point B.
- Repeat steps 5 and 6 till the last point T2 reached.



CHECK:

The last point so located must coincide with the point of tangency T2 fixed independently by measurements from the point of intersection.

RESULT:

The given simple curve is thus set out.