



KG REDDY
College of Engineering
& Technology
AN AUTONOMOUS INSTITUTION

CELEBRATING
15
YEARS OF
BRILLIANCE

SURVEYING & GEOMATICS LABORATORY

LABORATORY MANUAL

Prepared By: Mr. G. Anvesh, Assistant Professor

**Department of Civil
Engineering**

Institute Vision

To become an institution which is internationally recognized for its holistic approach to engineering, innovative teaching and learning culture, research and entrepreneurial ecosystem, and sustainable social impact in the community.

Institute Mission

- To offer undergraduate and post-graduate programs which are supported through industry relevant curriculum and innovative teaching and learning processes that would help students succeed in their professional careers.
- To provide faculty and students with an ecosystem that fosters innovation, research, entrepreneurship, and international exposure through strategic partnerships with government organizations and collaboration with industries.
- To provide holistic learning environment to students which will contribute to their personal and professional growth and enable them to become leaders in their respective fields.
- To contribute to the development of the region by using our technological expertise to work with nearby communities and support them in their social and economic development

Department Vision

To be recognized for excellence in teaching, innovation, and research aimed towards betterment of society through sustainable infrastructural development.

Department Mission

- To integrate innovative teaching and learning practices that will enable students to build technical competence for working in civil engineering industries.
- To encourage innovation, research, and entrepreneurship among faculty and students that will lead to sustainable development.
- To become self-sustainable through strategic collaborations with industries and nearby communities focused on consultancy services.

Program Educational Objectives

- **PEO1:** Graduates will be able to work in multidisciplinary teams focused on development of infrastructure, design, sustainability, construction management and all the other related fields of Civil Engineering.
- **PEO2:** Graduates will be professionally competent through their ability to use modern civil engineering tools and manage projects in leadership positions.
- **PEO3:** Graduates will transform into change makers who will work towards societal development and advocate for equity, social justice, and sustainable development.

Program Outcomes

PO 1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO 2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1, WK2)

PO 3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO 4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO 5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling, recognizing their limitations to solve complex engineering problems. (WK2 & WK6)

PO 6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for an appeal of sustainability, with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO 7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion, adhere to national & international laws (WK9)

PO 8: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO 10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO 11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Program Specific Outcomes (PSO's)

PSO1: Graduates will be able to plan, analyze, design safe and sustainable green infrastructure.

PSO2: Graduates will be able to utilize the latest software tools for modeling and simulation in the field of civil engineering.

PSO3: Graduates will be able to work in multidisciplinary teams to design, develop and promote smart construction related.

SURVEYING & GEOMATICS LABORATORY

Course Objectives: The objectives of this course for the student are to:

1. Distinguish the various basic concept and principles used in surveying, like Chain Surveying, Compass Surveying, Plane Table Surveying, and Leveling Surveying.
2. Elaborate about theodolite and total station in surveying.
3. Calculate Area of plot and Ground.
4. Determine the Horizontal Angle, Vertical Angle, Horizontal distance, and Vertical distance to study the ground profile using a total station.
5. Determine the purpose of DGPS

Course Outcomes: After completion of this course, the students will be able to

CO1: Prepare Map and Plan for required site with suitable scale.

CO2: Prepare contour Map and Estimate the Quantity of earthwork required for formation level for Road and Railway Alignment.

CO3: Judge which type of instrument to be used for carrying out survey for a Particular Area and estimate the area.

CO4: Judge the profile of ground by observing the available existing contour map.

CO5: Demonstrate about DGPS

Department of Civil Engineering

Surveying & Geomatics Laboratory

Course Code: KG25ACE230

B. Tech. II Year I - Semester

LIST OF EXPERIMENTS:

CYCLE - I

1. Measurement of horizontal angles and vertical angles.
2. Distance between two inaccessible points.
3. Measurement of area by theodolite traversing (Gales traverse table).
4. Determination of tachometer constants.
5. Distance between two inaccessible points using the principles of tachometer surveying.
6. Distance between two inaccessible points using the principles of trigonometric surveying

CYCLE – II

Total Station:

7. Area Measurement.
8. Stake Out
9. Remote Elevation Measurement
10. Missing Line Measurement
11. Longitudinal & Cross Section Profile
12. Contouring
13. Providing a Simple Circular Curve
14. Demonstration using DGPS.

MANDATORY INSTRUCTIONS

1. Students should report to the labs concerned as per the timetable.
2. Record should be updated from time to time and the previous experiment must be signed by the faculty in charge concerned before attending the lab.
3. Students who turn up late to the labs will in no case be permitted to perform the experiment scheduled for the day.
4. After completion of the experiment, certification of the staff in-charge concerned in the observation book is necessary.
5. Students should bring a notebook of about 100 pages and should enter the readings/observations/results into the notebook while performing the experiment.
6. The record of observations along with the detailed experimental procedure of the experiment performed in the immediate previous session should be submitted and certified by the staff member in-charge.
7. The group-wise division made in the beginning should be adhered to, and no mix up of student among different groups will be permitted later.
8. The components required pertaining to the experiment should be collected from Lab- in-charge after duly filling in the requisition form.
9. When the experiment is completed, students should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.
10. **Any damage of the equipment or burnout of components will be viewed seriously either by putting penalty or by dismissing the total group of students from the lab for the semester/year.**
11. Students should be present in the labs for the total scheduled duration.
12. Students are expected to prepare thoroughly to perform the experiment before coming to Laboratory.

13. Procedure sheets/data sheets provided to the students groups should be maintained neatly and are to be returned after the experiment.
14. DRESS CODE:
 - i. Boys - Formal dress with tuck in and shoes
 - ii. Girls - Formal dress
 - iii. **Apron for both boys and girls.**

Cycle - I

EXPERIMENT NO. 1

MEASUREMENT OF HORIZONTAL ANGLES AND VERTICAL ANGLES

OBJECTIVE:

MEASUREMENT OF HORIZONTAL ANGLES AND VERTICAL ANGLES

AIM: Measurement of horizontal angle by the method of repetition

INSTRUMENTS REQUIRED: Theodolite, tape, ranging rods, tripod etc

PROCEDURE:

- 1) Set up the instrument over 'O' and level it accurately.
- 2) With the instrument on the left face, set verniers A to 3600 and with the aid of the lower clamp and tangent screw, bisect signal A.
- 3) Check the reading on verniers A&B and note it.
- 4) Release the upper plate, swing the telescope to the right and bisect the right hand signal B with the upper clamp and tangent screw bisect single A.
- 5) Release the lower clamp, swing instrument to the right and turn to signal A. Clamp the lower motion and with lower tangent screw bisect signal A.
- 6) Release upper clamp, swing instrument to the right and again bisect signal B accurately with the upper clamp and tangent screw. The vernier reading will be twice the angle AOB.
- 7) Repeat the procedure until the angle is repeated the required number of times.
- 8) Change face to right and repeat the above procedure.
- 9) The average horizontal angle AOB will be the mean of the value of the angle as

OBSERVATIONS:

Measurement of horizontal angle by the method of repetition

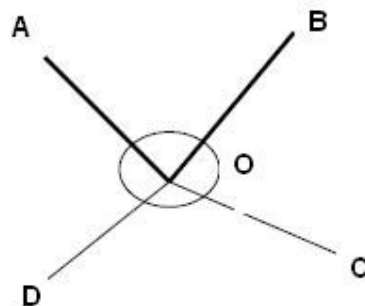
Instrument station	Object	Face	No of reading	Initial reading on vernier		Final on reading	Angle on vernier	Mean on vernier
				A	B	mean		
P	Q	LEFT	1					
	R		2					
			3					
P	Q	RIGHT	1					
	R		2					
			3					

OBJECTIVE:

To measure horizontal angle by reiteration method.

EQUIPMENTS:

- Transit Theodolite
- Tripod and
- Ranging rods



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.

(B) MEASUREMENT OF VERTICAL ANGLE

Aim: To measure the vertical angle subtended by the line of sight of a given rod with reference to the horizontal axis at a selected station.

Equipment: Transit Theodolite, Tripod Stand, Plumb Bob, Ranging Rod and Pegs.

Principle: The vertical angle is the angle made by an inclined line of sight with horizontal line of sight. Vertical angles are measured by using telescope clamping and telescope tangent screws.

Procedure:

1) Let $\angle AOB$ is to be measured (Fig.4):

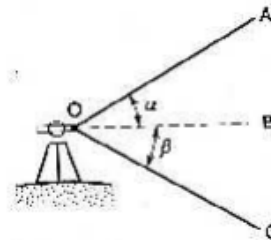


Fig.4 Measurement of Vertical Angle

i) Setup the instrument doing the exact adjustments (centering, leveling and focusing the eyepiece)

ii) The centering is done with reference to altitude bubble.

iii) Keep the instrument in the left position make the vernier 'C' read zero with the help of vertical circle clamp & tangent screws.

iv) Bring the altitude bubble to zero when the telescope is horizontal.

v) Direct the telescope to the object and bisect it accurately by means of the vertical circle clamp and tangent screw.

vi) Read both the vernier 'C' and 'D' and take the average, which gives the value of vertical angle.

vii) Change the face and repeat the procedure.

viii) The required vertical angle is the average of face left and face right.

2) Let $\angle AOC$ is to be measured (Fig.4):

- i) The instrument is already setup on the station at 'O'.
- ii) Direct the telescope to the top of the rod and bisect it accurately by means of the vertical.
- iii) Read the both verniers 'C' and 'D' and take the average which gives the value of vertical angle ' α '
- iv) Then the telescope is bisected to the bottom of the rod. Then read the both verniers 'C' and 'D' readings the average gives the value of vertical angle ' β '
- v) The summation of α & β gives the $\angle AOC$.
- vi) The face is changed and same procedure should be repeated then find $\angle AOC$.
- vii) The average of this two gives the $\angle AOC$.

Measurement of Vertical angle

Instrument station	Object	Face	No of reading	Reading on vernier		Angle on vernier	Mean on vernier
				C	D		
		LEFT	1				
			2				
			3				
		RIGHT	1				
			2				
			3				

EXPERIMENT NO -2

Distance between two inaccessible points

Objective:

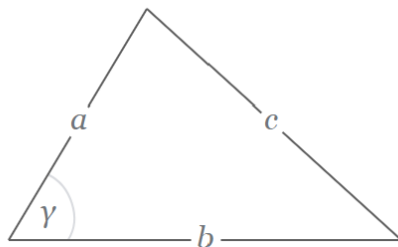
To determine the distance between two points that cannot be directly measured due to an obstacle using a theodolite.

Apparatus Required:

- Theodolite
- Tripod
- Measuring tape
- Ranging rods
- Arrows
- Plumb bob

Procedure:

1. **Set Up the Theodolite:**
 - Set up the theodolite at station A and level it properly.
 - Mark points A and B on either side of the obstacle such that both points are visible from a third point C.
2. **Measure Angle α at Point C:**
 - Set up the theodolite at point C.
 - Measure the angle between AC and BC (denoted as α).
3. **Measure Baseline AB:**
 - Measure the distance between points A and B using a measuring tape. This is the baseline (denoted as AB).



$$c = \sqrt{a^2 + b^2 - 2ab \cdot \cos \gamma}$$

- c = length of side c
- a = length of side a
- b = length of side b
- γ = angle opposite c

Use cosine rule formula to calculate the distances between the inaccessible points.

Observations: Record the horizontal angles and baseline distance.

Calculations :

Results: Distance between the two inaccessible points _____

EXPERIMENT NO -3

Measurement of Area by Theodolite Traversing (Gales Traverse Table)

Objective:

To determine the area of a closed traverse using the Gales traverse table.

Apparatus Required:

- Theodolite
- Tripod
- Measuring tape
- Ranging rods
- Arrows
- Gales traverse table

Procedure:

1. **Set Up the Traverse:**
 - Mark the traverse points on the field (e.g., A, B, C, D).
 - Set up the theodolite at each station and measure the angles between the traverse lines.
2. **Measure the Length of Each Traverse Line:**
 - Measure the lengths of all the traverse sides using a measuring tape.
3. **Calculate the Bearings:**
 - Calculate the bearings for each traverse line.
4. **Fill in the Gales Traverse Table:**

EXPERIMENT NO -4

Determination of Tachometer Constants

Objective:

To determine the tachometric constants K and C using a known distance.

Apparatus Required:

- Tachometer (Theodolite with stadia diaphragm)
- Staff
- Tripod
- Measuring tape

Procedure:

1. Set Up the Instrument:

- Set up the tachometer at a known station and level it.

2. Measure the Staff Readings:

- Observe the staff held vertically at a known distance. Note the readings for the top (S1), middle (S2), and bottom (S3) stadia hairs.

3. Calculate the Difference in Readings:

- Calculate the difference between the top and bottom stadia readings (S1 - S3).

4. Calculate the Tachometric Constants:

Use the formula:

$$K = D - C / S1 - S3$$

Where:

- D = Known distance from the instrument to the staff
- K = Multiplying constant
- C = Additive constant

Repeat for Different Distances:

- Repeat the process for different distances to get more accurate values of K and C.

Record Observations:

Distance (D)	Staff Reading (S1 - S3)	K (calculated)	C (calculated)

Observations:

Results: Tachometric Constants

K =

C =

EXPERIMENT NO -5

Distance Between Two Inaccessible Points Using the Principle of Tachometer Surveying

Aim:

To determine the horizontal distance between two inaccessible points using tachometric surveying and applying tachometric constants.

Apparatus Required:

- Tachometer (Theodolite with a stadia diaphragm)
- Tripod
- Measuring tape
- Ranging rods

Theory:

In tachometric surveying, distances are calculated using the stadia method. The tachometer has two additional horizontal cross-hairs (stadia hairs) above and below the central hair. When the stadia hairs intercept a known staff length, the distance can be calculated using the formula:

$$D=k \cdot s+C$$

where:

- D = Horizontal distance between the instrument and the staff
- k = Multiplying constant (stadia interval factor, usually 100)
- s = Staff intercept (difference between the readings on the upper and lower stadia hairs)
- C = Additive constant (distance from the instrument's optical center to the vertical axis, typically measured during calibration)

Procedure:

1. Instrument Setup at Station A:

- Set up the tachometer at point A, ensuring it is leveled and centered using a plumb bob.
- Sight the first inaccessible point P using the central cross-hair, and read the stadia intercepts on the leveling staff held at point P.
- Record the top stadia reading, bottom stadia reading, and central reading.

2. Calculate Distance to Point P:

- **Compute the difference between the upper and lower stadia readings to get the staff intercept s.**
- **Apply the tachometric distance formula: $D=k \cdot s+C$**
- **Record the calculated distance D of AP**

3. Repeat for Point Q:

- Sight the second inaccessible point Q from station A, and take the stadia intercept readings.
- Calculate the distance AQ using the same formula.

Calculations :

Using the distances DAP ,DBP, and angle between them

Station	Upper Stadia Reading	Lower Stadia Reading	Staff Intercept (s)	Distance (m), $D=Ks+C$
A-P				
A-Q				

Apply the Law of Cosines to find the distance PQ:

Results: Distance between the two inaccessible points _____

EXPERIMENT NO -6

Distance Between Two Inaccessible Points Using Trigonometric Surveying

Objective:

To determine the distance between two inaccessible points using the principles of trigonometric surveying.

Apparatus Required:

- Theodolite
- Tripod
- Measuring tape
- Ranging rods

Procedure:

1. Set Up the Instrument:

- Set up the theodolite at a point from where both inaccessible points are visible.

2. Measure the Horizontal Angles:

- Measure the horizontal angles between the instrument station and the inaccessible points.

3. Measure the Vertical Angles:

- Measure the vertical angles to the inaccessible points.

4. Measure the Baseline Distance:

- Measure the baseline distance between the instrument station and one of the inaccessible points.

5. Calculate the Distance Using Trigonometric Relations:

- Use the sine and cosine rules and Sine Rule to calculate the distance between the inaccessible points.

6. Record Observations:

Calculations :

Results: Distance between the two inaccessible points _____

Cycle - II

Total Station

1. Area Measurement Stake Out
2. Remote Elevation Measurement
3. Missing Line Measurement
4. Longitudinal & Cross-Section Profile
5. Contouring
6. Providing a Simple Circular Curve
7. Demonstration using DGPS.



Precautions

1. Never point the instrument at the sun without a filter.
2. Never store the instrument in extreme temperatures and avoid sudden temperature changes.
3. When not using the instrument, place it in the case to avoid shock, dust, and humidity.
4. If there is a great difference in temperature between the work site and the instrument storage location leave the instrument in the case until it adjusts to the temperature of the surrounding environment.
5. Please remove the battery for separate storage if the instrument

is to be in storage for an extended time. The battery should be charged once a month during storage.

6. The instrument should be placed in its carrying case during transportation. It is recommended that the original packing case be used for cushioning during extended transportation.
7. Be sure to secure the instrument with one hand when mounting or removing from the tripod.
8. Clean exposed optical parts with degreased cotton or lens tissue only.
9. Clean the instrument's surface with a woolen cloth when finished with use. Dry it immediately if it gets wet.

EXPERIMENT NO -1

Area Measurement Stake Out

Objective

To measure an area using a Total Station with precision.

Apparatus Required

1. Total Station
2. Tripod
3. Reflector or prism
4. Pegs and hammer
5. Tape/chain for initial referencing
6. Field book for noting observations

Procedure

1. Preparation:

- Transfer the design coordinates (stakeout points) into the Total Station via a USB or manual entry.

2. Station Setup:

- Set up the Total Station at a known station point with reference to a base line.
- Input the instrument's station coordinates into the Total Station.

3. Orientation:

- Use back-sighting on a known reference point to orient the Total Station.
- paint.

4. Verification:

- Recheck the staked points by measuring their coordinates and comparing them with the design values.

Observations

- Record measured angles, distances, and coordinates in a field book.
- Document deviations between staked and design points if any.

Precautions

1. Ensure the Total Station is properly leveled and centered.
2. Maintain clear visibility between the instrument and prism.
3. Avoid vibrations and external disturbances during measurements.
4. Regularly check the battery level and backup data.

Result

- The area is calculated with the measured boundary points.
- Stakeout points are accurately positioned as per the design.

EXPERIMENT NO -2

Stake Out

Objective

To measure an area and perform stakeout using a Total Station with precision.

Apparatus Required

1. Total Station
2. Tripod
3. Reflector or prism
4. Pegs and hammer
5. Tape/chain for initial referencing
6. Field book for noting observations

Procedure

Preparation:

- Transfer the design coordinates (stakeout points) into the Total Station via a USB or manual entry.

Station Setup:

- Set up the Total Station at a known station point with reference to a base line.
- Input the instrument's station coordinates into the Total Station.

Orientation:

- Use back-sighting on a known reference point to orient the Total Station.

Stakeout Procedure:

- Select the desired point to stake out from the Total Station's memory.
- The instrument will display the horizontal angle, distance, and vertical angle to the target point.
- Guide the assistant holding the prism to the specified location by providing real-time feedback:
 - Adjust the position until the instrument indicates zero deviation (aligning to the target point).
- Mark the point on the ground using a peg or paint.

Verification:

- Recheck the staked points by measuring their coordinates and comparing them with the design values.

Observations

- Record measured angles, distances, and coordinates in a field book.
- Document deviations between staked and design points if any.

Precautions

- Ensure the Total Station is properly leveled and centered.
- Maintain clear visibility between the instrument and prism.
- Avoid vibrations and external disturbances during measurements.
- Regularly check the battery level and backup data.

Result

- The area is calculated with the measured boundary points.
- Stakeout points are accurately positioned as per the design.

EXPERIMENT NO -3

Remote Elevation Measurement

Objective

To determine the elevation of a remote point using a Total Station by measuring distances and vertical angles.

Apparatus Required

1. Total Station
2. Tripod
3. Prism (Reflector)
4. Leveling staff (if no prism)

Theory

The elevation of a remote point is calculated using trigonometric principles, where:

- **Vertical Angle (VA)** is the angle of elevation or depression measured from the Total Station.
- **Slope Distance (SD)** is the direct distance from the instrument to the target.
- **Instrument Height (HI)** is the height of the Total Station above the station point.
- **Target Height (HT)** is the height of the reflector or leveling staff.

Formulas Used

1. Elevation of Remote Point (P):

- For elevation above the instrument:

$$Elevation_P = HI + (SD \times \sin(VA)) - HT$$

- For elevation below the instrument:

$$Elevation_P = HI - (SD \times \sin(VA)) - HT$$

2. Horizontal Distance (HD):

$$HD = SD \times \cos(VA)$$

This is often recorded for reference but not needed for elevation calculation.

Procedure:

1. **Setup the Total Station:**

- Position the Total Station on a tripod at a known station point.
- Level the instrument accurately using the leveling screws and ensure the instrument is centered using the plumb bob or laser plummet.
- Measure and record the **Instrument Height (HI)**.

2. **Set the Target:**

- Position the prism (or leveling staff) at the remote point whose elevation is to be determined.
- Measure and record the **Target Height (HT)**.

3. Measure Vertical Angle and Distance:

- Sight the target through the Total Station.
- Measure the **Vertical Angle (VA)** (positive for elevation, negative for depression).
- Measure the **Slope Distance (SD)** to the target using the Total Station's EDM (Electronic Distance Measurement).

4. Record Observations:

- Note the Vertical Angle (VA), Slope Distance (SD), Instrument Height (HI), and Target Height (HT) in observation book.

5. Calculate Elevation:

- Apply the appropriate formula to compute the elevation of the remote point based on the recorded data.

Observation Table

Station Point	HI (m)	Remote Point	VA (°)	SD (m)	HT (m)	Elevation (m)

Precautions

1. Ensure the Total Station is properly calibrated.
2. Level and center the instrument accurately.
3. Keep the line of sight clear of obstructions.
4. Avoid measuring during extreme weather conditions like high winds or rain.
5. Recheck measurements for consistency.

Result

The elevation of the remote point is calculated accurately using Total Station measurements.

EXPERIMENT NO -4

Missing Line Measurement

Aim:-

To determine the length and bearing of a missing line between two points that cannot be directly measured, using a Total Station.

Apparatus Required

1. Total Station
2. Tripod
3. Prism (Reflector)
4. Tape/chain (optional)

Theory

The "missing line" is the line between two inaccessible points that cannot be measured directly due to obstacles or terrain. The Total Station is used to determine this line by triangulation, recording the angular and linear measurements from reference points.

Procedure

Setup the Total Station:

- Position the Total Station at a convenient station point A.
- Level the instrument accurately using the leveling screws and center it using the plumb bob or laser plummet.
- Input the coordinates or assume (0,0)(0,0)(0,0) for A.

Observe the First Target:

Sight the prism placed at one endpoint of the missing line, BBB.

Measure and record:

- Horizontal angle to B (θ_1).
- Slope distance from A to B (D1).

Move the Instrument:

- Relocate the Total Station to another station point C, ensuring it has a clear line of sight to both points B and D.
- Repeat the leveling and centering procedure.

Observe the Second Target:

- Sight the prism placed at D, the other endpoint of the missing line.
- Measure and record:
 - Horizontal angle to D (θ_2).
 - Slope distance from C to D (D2).

Compute the Missing Line:

Using the recorded data, calculate:

- The **bearing** of the missing line BD using trigonometry:
Bearing of BD=adjusted angle between lines AB and CD
- The **length of the missing line BD** using the law of cosines:

$$BD = \sqrt{D_1^2 + D_2^2 - 2 \times D_1 \times D_2 \times \cos(\Delta\theta)}$$

Observation Table

Station Point	Target	Horizontal Angle (θ)	Slope Distance (D)	Calculations

Precautions

1. Ensure precise leveling and centering of the Total Station.
2. Record measurements accurately in the field book.
3. Avoid obstructions along the lines of sight.
4. Use appropriate error correction for slope distance and angles.
5. Perform multiple readings to ensure consistency.

Result

The length and bearing of the missing line are calculated using Total Station observations. The procedure accurately determines the inaccessible line using triangulation.

EXPERIMENT NO -5

Longitudinal & Cross-Section Profile

Aim:-

To determine the longitudinal and cross-sectional profiles of a specific terrain or road for design and earthwork calculations.

Apparatus Required

1. Total Station
2. Tripod
3. Leveling Staff
4. Tape or Chain
- 5.

Definitions

- **Longitudinal Profile:** The vertical section of the ground surface along the centerline of a project (e.g., a road, railway, or canal).
- **Cross-Section Profile:** The vertical sections of the ground surface perpendicular to the centerline at specified intervals.

Procedure

A. Longitudinal Profile Survey

1. **Setup the Instrument:**
 - Position the Total Station or leveling instrument at a convenient point with a clear view of the alignment.
 - Level and center the instrument.
2. **Mark Chainage Points:**
 - Identify and mark chainage points along the centerline of the project at regular intervals (e.g., every 10m or 20m).
 - Also, mark additional points where the terrain changes significantly.
3. **Take Readings:**
 - For each chainage point:
 - Measure the Reduced Level (RL) by taking the backsight (if necessary) and foresight readings on the leveling staff.
 - Record the chainage and RL in the field book.
4. **Shift the Instrument:**
 - If the alignment extends beyond the instrument's range, move the instrument to the next convenient position.
 - Perform a height of instrument (HI) check by taking a backsight reading from the previous setup.

5. Plot the Longitudinal Profile:

- Transfer the chainage and RL data onto graph paper or software to create the longitudinal section.
- Represent the ground profile, proposed design line, and gradient.

B. Cross-Section Profile Survey

1. Select Cross-Section Points:

- At each chainage point, lay out perpendicular offsets on both sides of the centerline at fixed intervals (e.g., every 5m or 10m).
- Extend the offsets as needed to capture the full terrain variation.

2. Take Readings:

- Measure the RL of each offset point using the leveling instrument or Total Station.
- Record the offset distance and RL in the field book.

3. Plot the Cross-Section:

- Plot the offset distances on the x-axis and the RLs on the y-axis.
- Represent the ground profile for each cross-section.

Observation Table

Longitudinal Profile Table

Chainage (m)	Back Sight (m)	Height of Instrument (m)	Foresight (m)	Reduced Level (m)	Remarks

Cross-Section Profile Table

Chainage (m)	Offset Distance (m)	RL (m)	Remarks

Precautions

1. Ensure accurate leveling of the instrument at every station.
2. Mark chainage and offset points clearly.
3. Avoid parallax error when reading the staff.
4. Double-check calculations for RLs and plot consistency.
5. Ensure no obstructions block the line of sight.

Result

- The longitudinal profile provides a detailed representation of the ground elevation along the centerline.
- The cross-sectional profiles display terrain variations perpendicular to the alignment, useful for earthwork estimation and design purposes.

EXPERIMENT NO -6

Contouring

Aim:-

Contour plan of given area

Apparatus:-

- Dumpy level,
- Prismatic compass,
- Chain 20m, 30m,
- Metallic Tape,
- Ranging rod Leveling staff,
- Pegs line.

Theory:-

Contouring:-

The elevation and depression the undulations of the surface of the ground are shown as map by intersection of level surface with by means of contour line. a contour may be defined as the line of intersection of a level surface with the surface of the ground. Characteristics of CounterLines The following are the Characteristics of the contours/ contour lines.

- All points on the same contour line will have the same elevation.
- Contour lines close together represent steep ground, while uniform slope is indicated when they are uniformly spaced. A series of straight, parallel and equally spaced contours show a plane or flat surface.
- Contour lines of different elevation cannot merge or cross one another on the map, except in the case of an overhanging cliff. A vertical cliff is indicated when several contours coincide.
- A contour line must close upon itself either within or without the limits of the map.
- Series of closed contour lines on the map either represent a hill or a depression according as the higher or lower values are inside them as shown below.

- A contour will not stop in the middle of the plan. It will either close or go out of the plan.
- Ridge or water shed and valley lines are the lines joining the top most or the bottom most points of hill and valley respectively, cross the contours at right angles. A ridge line is shown when the higher values are inside the loop, while in the case of a valley line, the lower values are inside the loop .
- Contour lines are not drawn across the water in the stream or river because the water level in that is not constant; but contours are drawn along the bed of a river or a stream.

Uses of contour map:-

- For preparing contour map in order to select the most economical or a suitable site.
- For getting the importance about ground whether it is undulating or Mountainous.
- To locate the alignment of canal so that it should follow a ridge line, thus canal construction will be economical and will command maximum irrigated area.
- To make the alignment for the road, railway so that the quantity of earthwork both in
in
- cutting and filling should be minimum.
- To find out the capacity of the reservoir or a volume of earthwork especially in the Mountainous region.
- For preparing contour map in order to select the most economical or suitable site.
- As its definition itself indicates the line joining the points of same elevation that means it
- naturally prefers the condition of nature of ground itself.
- It is also used for irrigation purpose as from its capacity of reservoir.

Locating Contours:-

By cross-section method:-

This method is commonly used in rough survey, cross sections are run traverse to the contour line of road, and railway as canal and the point of change of slope (representations) are located. The cross-section line may be inclined at any angle To the centerline if necessary. The spacing of the cross sections depends upon the characteristics

of the ground. By interpolation of contour is meant the process of spacing the contour proportioning between the plotted ground points. Contour may be interpolated by

1. Estimation
2. Arithmetical calculations
3. Graphical method .in all these methods

It is assumed that the slope of the ground between any two random points is uniform.

Result:-

Thus the contour of given area is drawn in the sheet.

EXPERIMENT NO -7

Providing a Simple Circular Curve

Aim:-

To set out a simple circular curve using tangent length, offsets, and chord lengths.

Apparatus Required

1. Theodolite
2. Chain or tape
3. Ranging rods
4. Pegs
5. Hammer
6. Leveling staff

Theory

A simple circular curve connects two straight lines at an angle and has a constant radius R . Key elements include:

- **Tangent Length (T):** The distance from the tangent point to the intersection point.
- **Offset Distance (O):** Perpendicular distance from the curve to the tangent or chord.
- **Chord:** A straight line segment connecting two points on the curve.

Formulas Used

1. Tangent Length:

$$T = R \tan \left(\frac{\Delta}{2} \right)$$

Where:

Δ = Angle of intersection

R = Radius of the curve

2. Offset Distance:

$$O = R - \sqrt{R^2 - x^2}$$

Where:

x = Distance from the tangent to the point of offset along the curve

Procedure

1. Initial Setup:

- Identify the tangent points T_1 and T_2 from the intersection angle Δ and curve radius R .
- Measure and mark the tangent length T using $T = R \tan \left(\frac{\Delta}{2} \right)$.

2. Dividing the Curve:

- Divide the tangent length T into equal intervals x .
- These intervals determine the positions of offset points along the tangent.

3. Calculate Offsets:

- For each interval x , calculate the perpendicular offset $O = R - \sqrt{R^2 - x^2}$.

4. Setting Out Offsets:

- Use the calculated offsets O to position pegs perpendicular to the tangent line. Place pegs at each interval x .

5. Curve Verification:

- Use a theodolite or sighting to check the alignment of the placed pegs along the curve.
- Make adjustments if necessary to maintain curve smoothness.

6. Fixing the Curve:

- Once the pegs are accurately positioned, connect them using a smooth curve.

Observations

Record:

- Tangent length T
- Interval length x
- Offset distances O

Precautions

1. Ensure accurate measurement of angles and distances.
2. Use appropriate tools for perpendicular offsets.
3. Avoid disturbing pegs after they are fixed.

Result

The simple curve is set out accurately using tangent and offset methods. Validate by checking the smoothness and alignment of the curve.

EXPERIMENT NO -8

Demonstration using DGPS.

Aim:-

To demonstrate the use of DGPS for accurate positioning and surveying applications, including determining precise coordinates and elevations.

Apparatus Required

1. **DGPS Receiver:** Includes a base station and rover unit.
2. **Tripod:** For mounting the DGPS receivers.
3. **Field Book:** For recording observations.
4. **Surveying Software (optional):** For data processing.

Theory

DGPS enhances the accuracy of standard GPS by using a reference (base) station at a known location. The base station calculates correction signals based on satellite data and transmits them to the rover unit, improving positional accuracy to sub-meter or centimeter levels.

Key Concepts:

- **Base Station:** A stationary receiver at a known location.
- **Rover:** A mobile receiver used to measure unknown points.
- **Corrections:** DGPS corrects satellite errors such as atmospheric delays, clock drift, and multipath errors.

Procedure

1. Setup the Base Station

1. Select a known reference point for the base station.
2. Set up the base receiver on a tripod and align it with the reference point.
3. Power on the base station and configure it with the known coordinates (latitude, longitude, elevation).
4. Start recording correction signals to be transmitted to the rover.

2. Setup the Rover

1. Mount the rover receiver on a tripod or pole for mobility.
2. Power on the rover and configure it to receive correction signals from the base station (via radio, Bluetooth, or satellite communication).

3. Surveying with DGPS

1. Navigate to the point to be measured.
2. Position the rover receiver exactly above the survey point using a plumb bob or laser plummet for vertical alignment.

3. Wait for the rover to establish a stable connection with the base station and satellites.
4. Record the coordinates (latitude, longitude, elevation) of the survey point.

4. Data Collection

- Repeat the measurement process at all required points.
- Ensure that the rover has consistent connection and signal quality at every point.
- Record data in the field book or store it digitally in the receiver.

5. Data Processing

- If necessary, download the recorded data from the base and rover units.
- Process the data using surveying software to correct and refine measurements.

Observation Table

Point ID	Latitude (°)	Longitude (°)	Elevation (m)	Horizontal Accuracy (m)	Vertical Accuracy (m)	Remarks

Precautions

1. Ensure the base station is set up at an accurately known location.
2. Avoid obstructions (buildings, trees) that may block satellite signals.
3. Minimize multipath errors by selecting open areas for the survey.
4. Regularly monitor satellite signal strength and number of satellites in use.
5. Maintain communication between the base and rover throughout the survey.

Result

Precise coordinates and elevations of the surveyed points are obtained using DGPS. This data is used for mapping, construction, and geospatial applications.

Applications

- Road and highway alignment.
- Construction site surveying.
- Mapping and GIS applications.
- Environmental studies and land use planning.



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